USE OF BIOSTRATIGRAPHY TO INCREASE PRODUCTION, REDUCE OPERATING COSTS AND RISKS AND REDUCE ENVIRONMENTAL CONCERNS IN OIL WELL DRILLING

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DISCLAIMER

ABSTRACT

In the Santa Maria Basin, Santa Barbara County, California, four wells were processsed and examined to determine the age and environment parameters in the oil producing sections. From west to east, we examined Cabot No. 1 Ferrero-Hopkins,from 3917.7 m (12850') to 4032 m (13225'); Sun No. 5 Blair, from 3412 m (11190') to 3722.5 m (12210'); Triton No. 10 Blair, from 1552 m (5090') to 1863 m (6110'); and OTEC No. 1 Boyne, from 2058 m (6750') to 2528 m (8293'). Lithic reports with lithic charts were prepared and submitted on each well. These tested for Sisquoc Fm lithology to be found in the Santa Maria area. This was noted in the OTEC No. 1 Boyne interval studied. The wells also tested for Monterey Fm. lithology, which was noted in all four wells examined. Composite samples of those intervals [combined into 9.15 m (30 foot) intervals] were processed for paleontology. Although the samples were very refractory and siliceous, all but one (Sun 5 Blair) yielded index fossil specimens, and as Sun 5 Blair samples below 3686 m (12090') were processed previously, we were able to make identifications that would aid this study.

The intervals examined were of the Sisquoc Formation, the Low Resistivity and the High Resistivity sections of the Monterey Formation. The Lower Sisquoc and the top of the late Miocene were identified by six index fossils: *Bolivina barbarana, Gyroidina soldanii rotundimargo, Bulimina montereyana, Prunopyle titan, Axoprunum angelinum* and *Glyphodiscus stellatus.* The Low Resistivity Monterey Fm. was identified by eight index fossils, all of which died out at the top of the late Miocene, late Mohnian: *Nonion goudkoffi, Brizalina girardensis, Cibicides illingi, Siphocampe nodosaria, Stephanogonia hanzawai, Uvigerina modeloensis, Buliminella brevior, Tytthodiscus sp.*and the wide geographic ranging index pelagic fossil, *Sphaeroidinellopsis subdehiscens.* The High Resistivity Monterey Fm. was identified by eight index fossils, all of which died out at the top of the late Miocene, early Mohnian: *Bolivina aff hughesi, Rotalia becki, Suggrunda californica, Virgulina grandis, Virgulina ticensis, Bulimina ecuadorana, Denticula lauta* and *Nonion medio-costatum.* Please see Appendix B, Fig. 1, Neogene Zones, p. 91 and Appendix C, chart 5, p. 99

By the use of Stratigraphy, employing both Paleontology and Lithology, we can increase hydrocarbon production, reduce operating costs and risks by the identification of the productive sections, and reduce environmental concerns by drilling less dry holes needlessly.

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INTRODUCTION

PURPOSE

The purpose of this investigation is to determine the presence or absence of any marker fossil forms and lithology that will provide data to determine the age, lithic units and environments of deposition of the sediments encountered in four wells drilled in the Santa Maria Basin, Santa Barbara County, California. Identifying the micropaleontological characteristics of sedimentary sections in these wells will enable us to recognize the respective horizons as they are being drilled in future exploratory or development wells. The wells to be drilled will penetrate a deeper lying footwall trend which has an estimated ultimate recovery of 400,000,000 barrels of oil. Thus we can increase production, reduce operating costs and risks,and reduce environmental concerns in future drilling.

SETTING

The four wells studied are situated in a line running essentially west to east from Section 1, Township 7 North, Range 33 West to Section 11, Township 7 North, Range 32 West, San Bernardino Base and Meridian, Santa Maria Area, Santa Barbara County, California. The area lies in the northern portion of Santa Barbara County, north of Lompoc and south of San Luis Obispo County in California.

STUDIES

This report has concerned itself with the lithology and paleontology found in the following wells and intervals:

CABOT No. 1 Ferrero Hopkins, Sec. 1, T 7 N./R 33 W., SBB & M.
3917.7 m (12850') to 4032 m (13225')
SUN No. 5 Blair, Sec. 4, T 7 N. / R 32 W., SBB & M.
3412 m (11190') to 3722.5 m (12210')
TRITON No. 10 Blair, Sec. e T 7.N/R 32 W., SBB & M.
1552 m (5090') to 1863 m (6110')
OTEC No. 1 Boyne, Sec. 11, T 7 N./R32 W., SBB & M
2058 m (6750') to 2528 m (8293')

This work was performed the better to understand the ages, lithic units and environments of deposition in the subsurface Santa Maria area. The goal is to increase production, reduce operating costs and risks, and reduce environmental concerns in oil drilling by identifying oil zones by means of paleontology and lithology.

LITHOLOGY

Lithology refers to the rock content of a sample, whether sand, clay, limestone or other material in which paleontological specimens are found. Knowledge of lithology provides valuable information regarding paleofacies (whether marine turbidites, pelagic deposits, stream or channel sediments) and paleoenvironments (whether deposited in deep or shallow marine waters, or quiet, low energy, or high energy turbid deposition). This information also serves as a correlation tool over a larger area than just the one well being studied.

Percentage Lithic Analysis. This important method allows us to examine rock samples quickly and to make a log displaying the sands, clays, shales and minerals encountered. Samples are tested with Hydrochloric Acid to determine calcareous contents. These samples are examined also under an ultra-violet lamp to evaluate oil fluorescence. The lithic charts of all four wells are included in this report as Appendix D.

BIOSTRATIGRAPHY

This is the use of fossils to determine the ages of sediments as well as the lithic units and the environments of deposition encountered. Contemporaneous plant and animal remains are carried by non-marine streams and then offshore by currents, mixing with marine assemblages. The remains are buried with sediments at depositional sites. By considering paleontology and paleobotany together with an interdisciplinary approach, vastly superior results are provided. The purpose of this study is to provide age and environment information found with the net result of bringing all information together.

Paleontology. Here we study fossil microscopic animals such as Foraminifera, Radiolaria or fish scales or bones to provide information as to the ages and the environments of deposition of the rocks.

Paleobotany. The studies of plant remains, such as diatoms, plant seed pods, wood fragments, spores and pollen, and algal cysts are important indicators of both age and environmental deposition in shallow and deep marine settings. The algal cyst, *Tytthodiscus sp.* ranges from Jurassic to late Miocene, late Mohnian. Diatoms, such as *Coscinodiscus symbolophora,* proved to be helpful in age-dating the late Miocene, late Mohnian in the Triton 10 Blair.

By putting Paleontology and Paleobotany together with Lithology we use an interdisciplinary approach which provides results vastly superior than those using only one method or another.

EXECUTIVE SUMMARY

Intervals in 4 wells in the Santa Maria Basin, Santa Barbara Co., California, were studied to increase production, reduce operating costs and risks, and reduce environmental concerns in hydrocarbon exploration. From west to east, the following are the wells, locations and sample intervals:

TRITON No. 10 Blair, Sec. e T 7.N/R 32 W., SBB & M.
1552 m (5090') to 1863 m (6110'), 34 cuttings samples
OTEC No. 1 Boyne, Sec. 11, T 7 N./R32 W., SBB & M
2058 m (6750') to 2528 m (8293'), 66 cuttings samples
SUN No. 5 Blair, Sec. 4, T 7 N. / R 32 W., SBB & M.
3412 m (11190') to 3722.5 m (12210'), 34 cuttings samples
CABOT No. 1 Ferrero Hopkins, Sec. 1, T 7 N./R 33 W., SBB & M.
3918 m (12850') to 4032 m (13225'), 13 cuttings samples

The purpose was to determine the presence or absence of index fossils and lithology that will provide data to determine the age, lithic units and environments of the sediments found in the above intervals. Both lithology and paleontology provided answers and helped identify the Sisquoc, the Low Resistivity Monterey and the High Resistivity Monterey sections in the well intervals studied.

The following are the wells, lithologic units, ages and index fossils backing this up:

TRITON No. 10 Blair
1552 m – 1643 m (5090-5390') **Low Resistivity Monterey Fm.,**
late Miocene, late Mohnian
*Tytthodiscus sp.*Jurassic to late Miocene,late Mohnian
Nonion goudkoffi, late Miocene, late Mohnian
Brizalina girardensis late Miocene, Mohnian
Buliminella brevior, late Miocene, Luisian to Mohnian
Low/High Resistivity Marker: 1650 m (5413')
1652 m – 1863 m (5420' 6110') TD **High Resistivity Monterey Fm.**
late Miocene, early Mohnian
Virgulina ticensis late Miocene, early Mohnian
Nonion medio-costatum middle Miocene, Relizian to late Miocene, early Mohnian

OTEC No. 1 Boyne
2085 m – 2149 m (6840-7050'), 2528 m (8293') **Lower Sisquoc Fm.**
late Miocene, early Delmontian
Gray shales, typical of Sisquoc Fm.

EXECUTIVE Summary, Cont'd

OTEC No. 1 Boyne, Cont'd

2149 m – 2232 m (7350-7320') **Low Resistivity**.**Monterey Fm.**
late Miocene, late Mohnian
Sphaeroidinellopsis subdehiscens late Miocene N13-late Miocene, late Mohnian N15
Uvigerina modeloensis late Miocene, Mohnian
Low/High Resistivity Marker Not noted (no electric log this deep in the well)
2232 m – 2527 m (7320-8290') **High Resistivity Monterey Fm.**
late Miocene, early Mohnian
Virgulina ticensis, late Miocene, early Mohnian
Virgulina grandis, late Miocene, early Mohnian

SUN 5 BLAIR

Low/High Resistivity Marker: 3434 m (11230')
3412 m - 3686 m (11190-12090') – Age Indeterminate, no index fossils found
3686 m – 3695 m (12090-12120') late Miocene, Mohnian.
Stephanogonia hanzawai late Miocene, Mohnian
3695 m – 3713 m (12120-12180') late Miocene, early Mohnian
Bolivina aff. hugfhesi late Miocene, early Mohnian
Rotalia becki late Miocene, early Mohnian
Suggrunda californica, late Miocene, early Mohnian
Denticula lauta, late Miocene, Luisian to early Miocene
Nonion medio-costatum middle Miocene, Relizian to late Miocene, early Mohnian

CABOT 1 Ferrero-Hopkins

Low/High Resistivity Marker: 3840 m (12595')
3918 m – 4032m (12850-13225') Probably in High Resistivity Monterey Fm. e Mohnian.
Prunopyle titan – late Miocene Luisian to early Delmontian
Axoprunum angelinum – late Miocene Mohnian to early Delmontian
Glyphodiscus stellatus - middle to late Miocene

From the above, we can see that the electric log characteristics in the Monterey Formation change in the late Miocene, Mohnian aged sediments. The late Mohnian aged Monterey electric log shows as a low resistivity unit, and the early Mohnian aged Monterey electric log shows as a high resistivity unit, prone to have hydrocarbons.

This can increase production, reduce operating costs and risks, and reduce environmental concerns by being able to drill less wells to find oil or gas. This is by being able to identify sections above oil zones, sections in oil zones, and sections below oil zones.

EXPERIMENTAL
(METHODS)

Methods consist of two-fold processing and examination of samples:
1. Lithology
2. Paleontology, including Paleobotany

LITHOLOGY

Samples were examined for lithology in each of the four wells as follows:

CABOT No. 1 Ferrero Hopkins, Sec. 1, T 7 N./R 33 W., SBB & M.
3917.7 m (12850') to 4032 m (13225'), 13 cuttings samples
SUN No. 5 Blair, Sec. 4, T 7 N. / R 32 W., SBB & M.
3412 m (11190') to 3722.5 m (12210'), 34 cuttings samples
TRITON No. 10 Blair, Sec. e T 7.N/R 32 W., SBB & M.
1552 m (5090') to 1863 m (6110'), 34 cuttings samples
OTEC No. 1 Boyne, Sec. 11, T 7 N./R32 W., SBB & M
2058 m (6750') to 2528 m (8293'), 66 cuttings samples

Processing and Analysis. From each of the above samples about 10 cc. of rock material were placed in a petri dish and double decanted with water until the water appeared clear. The samples were examined under an ultra-violet lamp to detect oil fluorescence. The samples were then examined under a low-power (to 200 magnifications) binocular microscope. A percentage analysis was made of the sample contents, according to the lithic type, whether clay, shale, silt, sand, limestone or whatever was found. Accompanying minerals and oil fluorescence were noted. A lithologic report was prepared and forwarded on each of the above wells. The data are also included in the stratigraphic reports, below. Appendix D, below, p. 100, displays the lithologic charts, submitted for each of the wells.

PALEONTOLOGY

Samples were examined for Paleontology in each of the four wells as follows:

CABOT No. 1 Ferrero Hopkins, Sec. 1, T 7 N./R 33 W., SBB & M.
3917.7 m (12850') to 4032 m (13225'), 13 cuttings samples
SUN No. 5 Blair, Sec. 4, T 7 N. / R 32 W., SBB & M.
3412 m (11190') to 3722.5 m (12210'), 34 cuttings samples
TRITON No. 10 Blair, Sec. e T 7.N/R 32 W., SBB & M.
1552 m (5090') to 1863 m (6110'), 34 cuttings samples
OTEC No. 1 Boyne, Sec. 11, T 7 N./R32 W., SBB & M
2058 m (6750') to 2528 m (8293'), 51 cuttings samples

Processing and Analysis. All of the samples above were then processed for Micropaleontology. The sample is first crushed in a mortar and pestle to small pieces, then approximately 50 cc are measured into a beaker. Water is added, and the sample soaked at least overnight. The water is decanted and the sample is dried under low heat. A solvent of approximately 120 aromatics is added to the sample and allowed to soak overnight. The solvent is then decanted, and hot soapy water is added to the sample. Again, the sample soaks at least overnight. The sample is washed through sieves as will be discussed below.

The samples proved to be refractory, containing much porcellanite. Each sample was returned to beaker, and caustic soda, sodium hydroxide, also called Lye, was added to each sample and cooked for at least an hour. All samples were then double decanted three times to bring sample back to a pH of 7. The sample was placed in a "Bransonic" sonic bath and vibrated for at least an hour.

The samples were then washed through three sieves as follows:

Mesh	Opening
10	2 mm.(0.078 inch)
200	75 micron (0.0029 inch)
400	38 micron (0.0015 inch)

If anything were present on the 10 mesh sieve, it is dried and placed in a labeled plastic packet. That which is caught on the 400 mesh sieve is similarly dried and placed in a labeled plastic packet. The material caught on the 200 mesh sieve is dried and run through the following sieves:

Mesh	Opening
20	850 micron (0.328 inch)
40	425 micron (0.0165 inch)
60	250 micron (0.0097 inch)
80	180 micron (0.0069 inch)
100	150 micron (0.0058 inch)

The bottom tray of the set of sieves catches the 200 mesh sieving. Each sieving as well as the 200 mesh bottom tray material is placed in a separate, labeled plastic packet for examination under a low power binocular microscope with magnifications to 200 power.

Each of the samples from each well was processed and examined. At least four traysful of each sieving are very carefully examined. The flora and fauna are removed from

the sieving, mounted on slides, and entered into a spreadsheet to be displayed in the narrative reports, the fossil distribution charts, and if significant, displayed on the range charts. The Stratigraphic Reports are included here as Appendix A, p. 25, below.

REPORTS

LITHOLOGY

A percentage analysis of the sample is performed, determining first the main rock element in a sample, then assigning a percentage to the next most common rock material, and so down the scale. Accessory minerals and their types and varieties are also estimated. In the case of a sand, the sand color, grain size, angularity (or roundness), clarity and coating, if any, are described. When noting a clay, shale or siltstone, the color, massiveness or fissility, and hardness are described. A reaction to Hydrochloric Acid, whether low, medium or high, is noted. This would indicate a calcitic deposit or limestone. Samples with Hydrochloric Acid reactions were noted and plotted on the lithologic chart. Each sample was examined under an ultra-violet light to detect oil fluorescence,. Such data were displayed on the lithologic chart. Any fossil content, if found, is reported at this time. Lithologic Reports and Charts were submitted as follows:

OTEC No. 1 Boyne – Lithologic Report, 24 July 2003
OTEC No. 1 Boyne – Lithologic Chart, 11 August 2003
TRITON No. 10 Blair – Lithologic Report, November 2003
TRITON No. 10 Blair – Lithologic Chart, 17 November 2003
SUN No. 5 Blair – Lithologic Report, 22 December 2003
SUN No. 5 Blair – Lithologic Chart, 7 January 2004
CABOT No. 1 Ferrero- Hopkins – Lithologic Report, 31 December 2003
CABOT No. 1 Ferrero-Hopkins – Lithologic Chart, 12 January 2004

The lithology for each sample in each well is included in the Stratigraphic Reports, Appendix A, p. 25, below. Lithologic Charts and discussions are in Appendix D, p. 100, below.

PALEONTOLOGY

As described above, each sample is sieved into 8 sizes for more discerning examination. If enough material is present, at least three traysful of material are examined. For this project, four traysful of each sieving of each sample were analyzed, making thirty two traysful for each sample. Each sieving is examined for both plant and animal evidence, such as algal cysts, diatoms, vertebrate bone, scale, tooth, etc., foraminiferal or radiolarian tests, molluscan shell, sponge or echinoid remains, worm tubes, ostracode or other arthropod material.

In spite of a low fossil population, we were able to identify 118 different taxa in the wells. Plant evidence found was in the form of algae (Diatoms and algal cysts).and pollen. Key microscopic animal forms include the protist Foraminifera and Radiolaria. The Foraminifera indicate Marine water depths from Shallow Marine to Bathyal or deeper. References are indicated by numbers in brackets, i.e. [1]. Stratigraphic Reports were forwarded as follows:

OTEC No. 1 Boyne – Stratigraphic Report, 25 May 2004
TRITON No. 10 Blair – Stratigraphic Report, 29 November 2004
SUN No. 5 Blair – Progress Stratigraphic Report, 27 May2005
SUN No. 5 Blair - Stratigraphic Report, 3 June 2005
CABOT No. 1 Ferrero-Hopkins – Stratigraphic Report, 27 June 2005

Ranges. Of greatest importance is the presence of twenty nine index markers that can be used to help correlate the sediments in these wells to find oil.

In the **TRITON 10 Blair**, there were sixteen index fossils. The pelagic algal cyst, *Tytthodiscus sp.* ranging from Jurassic to Late Miocene, late Mohnian [19], is present. This permitted us to place the interval 1552 m- 1652 m (5090' – 5420') in TRITON No. 10 Blair in the late Miocene, late Mohnian, Low Resistivity Monterey Formation. The pelagic radiolarian marker, *Prunopyle titan,* Luisian to early Delmontian [6, 7] was noted in the samples from 1588 m. (5210') down,. Confirming this, the early Mohnian form *Virgulina ticensis* found in the sample at 1652m – 1753 m (5420'-5750') in TRITON No. 10 Blair is placed at the top of the Late Miocene, early Mohnian, Monterey Formation [16:151] just below the High Resistivity Monterey marker. Other important index fossils include the Monterey forms, *Rotalia garveyensis* [16:149,17:97], found in samples from 1680 m (5510') down; and the Mohnian markers, *Bolivina barbarana* [16:138] and *Brizalina girardensis* [16:138] from 1744 m (5720') down. The Late Miocene, early Mohnian, *Nonion medio-costatum* [16:146] was noted in the sample at 1753 m (5750').

The above index fossils in the Triton 10 Blair, proved the existence of the Low Resistivity Monterey Formation from 1552 m. (5090') to 1643 m (5390'). This coincides

with the late Miocene late Mohnian interval. Coinciding with the High Resistivity Monterey Formation is the late Miocene early Mohnian interval from 1652m (5420') to 1863 m (6110'). **This is a major breakthrough in Stratigraphy.**

In the **OTEC 1 Boyne** well**,**. of greatest importance is the presence of seven index markers that can be used to help correlate the sediments in this well. The pelagic radiolarian marker, *Prunopyle titan,* Luisian to early Delmontian [6, 7] was noted in the sample at 2067 m.- 2076 m. (6780-6810'), permitting us to place the interval 2057 m to 2149 m (6750' to 7050') in the Late Miocene Sisquoc Formation, as there were no deeper forms. A pelagic foraminiferal marker, *Sphaeroidinellopsis subdehiscens,* was found in the sample at 2149 m – 2158 m (7050-7080'). This helps date the section from 2158 m (7050') to 2232 m (7320') as late Mohnian in age, and in the Late Miocene Montery Formation [15]. The early Mohnian form *Virgulina ticensis* found in the sample at 2232 m – 2241 m (7320-7350'). is placed at the top of the Late Miocene, early Mohnian Monterey Formation [16:151]. Other important markers include the Monterey form, *Rotalia garveyensis* [16:149,17:97] found in samples from 2213 m (7260') to 2515 m (8250').

The index fossils in the OTEC 1 Boyne proved the existence of the Low Resistivity Monterey Formation from 2149 m (7050') to 2234 m (7320'), coinciding with the late Miocene, late Mohnian, interval. The late Miocene, early Mohnian, interval was noted from 2234 m (7320') to 2527 m (8290'). Without any e-logs in this section, we place this interval in the High Resistivity Monterey Formation. Please see Correlation Chart, Appendix B, p. 92.

In the **SUN No. 5 Blair,** no markers were found between the DOE interval 3412 m (11190') to 3686 m (12090'). Below that interval, previous work on this well [19], showed plant evidence found including algae (Diatoms and algal cysts) and palynomorphs. Below the interval examined, previous work [id.] revealed microscopic animal forms including the protist Foraminifera and Radiolaria. The Foraminifera indicate Marine water depths from Shallow Marine to Bathyal.

Ranges. Below the DOE interval examined, we found thirteen markers that can be used to help correlate the sediments in this well. The diatom, *Stephanogonia hanzawae* permitted us to place the interval 3686 m (12090') and below in the late Miocene, Mohnian, Monterey Formation [1]. The following species enabled us to place the sample 3704 m – 3713 m (12150'-12180') in the late Miocene, early Mohnian: *Bolivina aff. hughesi* [19]*, Denticula lauta* [3, 4, 20, 21]*, Suggrunda californica* [16]*, Rotalia becki* [5] and *Buliminella ecuadorana* [19] . Please see Appendix C, Range Chart, p.96.

The index fossils found in SUN 5 Blair, below the section examined for DOE, just below 3686 m (12090'), enabled us to place this interval in the late Miocene, early Mohnian, High Resistivity Monterey Formation. In the absence of an electric log, we can assume that this is the productive section in the footwall. Please see Appendix B, Correlation Chart, p. 92.

In the **CABOT No. 1 Ferrero-Hopkins** well, among the 12 taxa found, we noted three markers that can be used to help correlate the sediments in this well. The radiolarian, *Prunopyle titan*, found at 3927 m (12880') to 3945 m (12940') and 3963 m -3973 m (13000'-13030') ranges from Luisian to top of late Miocene and in the early Delmontian [1, 8, 20]. This permitted us to place the interval 3927 m (12880') and below in the late Miocene Monterey Formation. The radiolarian *Axoprunum angelinum*, found at 3973 m (13030') to 3991 m (13090') ranging in the middle to late Miocene, Monterey Formation [1, 20]. allows us to place it in the late Miocene Monterey Formation. The diatom, *Glyphodiscus stellatus,* noted at 4018 m – 4027 m (13180-13210'), also ranges from the middle to the late Miocene [1], and can be found in the Monterey Formation. Please see Appendix B, Figure 2, Correlation Chart, p. 92.

The range of the index fossils in the Cabot 1 Ferrero Hopkins well appear in the late Miocene Mohnian stage. This allows us to place the interval examined, 3918 m (12850') to 4032 m (13225') in the High Resistivity Monterey Formation.

Abundances. Among the 12 taxa found, most specimens were very rare (1 specimen) to rare (2 to 4 specimens) in the samples. Most samples had 1 species present. The sample at 3963 m -3973 m (13000-13030') had the most, with 6 taxa noted. We rate the fossil yield as POOR.

RESULTS AND DISCUSSION

RESULTS

Four wells, CABOT No. 1 Ferrero-Hopkins, SUN No. 5 Blair, TRITON No. 10 Blair and OTEC No. 1 Boyne, drilled in almost a straight line from west to east, were examined in a narrow zone encompassing the Low Resistivity Monterey Formation, the High Resistivity Monterey Formation and the Sisquoc Formation. The ages examined were from the late Miocene, early Mohnian, the late Miocene, late Mohnian, to the late Miocene, early Delmontian, Stages. Please see Appendix B, Fig. 1, Neogene Zones, p. 91. In millions of years, the sediments examined are considered to be from 14.5 to 5.5 millions of years old [13]. Please see Appendix C, Range Charts, pp. 95 to 99, below.

RESULTS OF INVESTIGATION, Frank Getz, Consulting Geologist

From the explorationist's standpoint, this study has been of great value, but the story is complex.

The original intent of the study was to facilitate drilling a well which was to be drilled to test a footwall anticline; the fossil succession in several nearby wells would be determined, and then, as the footwall test well was being drilled, its stratigraphic position at any depth could be determined by the fossil assemblage at that depth.

RESULTS OF INVESTIGATION, cont'd

While the application for a DOE grant was being processed, it became necessary, because of permitting requirements and drilling rig availability, to commence drilling the footwall test well. Drilling proceeded to 2530m (8297 feet), at which point drilling was halted for another routine bit change. While going back downhole with a new bit, the drill string got stuck in a key-seat at 732m (2400'). Because of hole conditions and budgetary constraints, it was decided to plug the original hole at 732m (2400'), sidetrack and drill to 1555m (5100 feet), T.D., and complete the sidetrack as a shallow, hangingwall, new fault block discovery. Initial production was 86 barrels net of oil per day.

But the much more important, original hole, footwall anticline test had been abandoned at 2530m (8297 feet) TD with only a mud log and a set of cuttings samples to show for all the effort. It became imperative to get as much information as possible from the cuttings, in order to determine the stratigraphy and structure of the borehole.

Approval for the DOE grant finally came through and the stratigraphic/paleontologic study of the OTEC No. 1 Boyne well and three nearby wells was carried out. As a result of the stratigraphic/paleontologic study we have determined the position of the important thrust fault zone and the structure and stratigraphy of its several thrust slice components. We are now able to proceed with much greater certainty in drilling future exploratory wells to test the footwall anticline.

And we are more than ever aware that good stratigraphic/paleontologic control is essential for deciphering complex geologic structure.

DISCUSSION

The L/H E-Log Marker. The intervals examined addressed the lithology and biostratigraphy of a Low Resistivity and a High Resistivity electric-log characteristics section in the late Miocene, Monterey Formation. By correlating lithological and paleontological data from all four wells studied, we have been able to arrive at a relationship at the Low-High Resistivity (L/H) E-Log point. In spite of a low fossil count, we have been able to place the intervals studied either above the Low-High Resistivity marker, in the late Miocene, early Mohnian, High Resistivity Monterey Formation, the late Miocene, late Mohnian, Low Resistivity Monterey Formation, or the late Miocene, early Delmontian, Sisquoc Formation. Please see Appendix B, Fig. 2, Correlation Chart, p. 92.

LITHOSTRATIGRAPHIC UNITS/AGES

SISQUOC FORMATION, **Late Miocene, early Delmontian,**

This unit is in the interval studied in **OTEC No. 1 Boyne** at 2085 m – 2149 m **(**6840'-7050') and 2528 m (8293').

LITHOSTRATIGRAPHIC UNITS/AGES, cont'd

Continually increasing down well to 2085 m – 2094 m (6840-6870') is a grey shale, making up 38±% of the sample, where 38±% of the sample is clay washed out of sample. The grey shale is typical of the Sisquoc Formation in this area. In the Santa Maria Area, as the Monterey is usually very refractory, clay washed out of sample is not normal. These are good diagnostic characteristics for the Sisquoc. The appearances of the gray shales, slickensides and clay washed out of sample are good indicators of Sisquoc [5:229,11:19]. A specimen of the Bathyal foraminifer *Sigmoidella* [2] was noted at 2104 m – 2113 m (6900-30').

MONTEREY FORMATION, (Low Resistivity) **Late Miocene, late Mohnian, to early Delmontian.**

OTEC No. 1 Boyne 2058 m to 2085 m **(**6750' to 6840')

The well section examined from 2058 m (6750') to 2085 m (6840') is predominantly a highly refractory brown shale.

The sample at 2067 m – 2076 m (6780-6810') contained the Luisian to early Delmontian [9, 10, 11, 20] *Prunopyle titan,* which would be found here. Other siliceous forms found here include Radiolaria sp, *Spongodiscus sp.* and diatoms. The Arenaceous foraminifer, *Haplophragmoides sp.* was first noted in the sample at 2058 m - 2076 m (6750-80').

MONTEREY FORMATION (Low Resistivity), **Late Miocene, late Mohnian,**

TRITON No. 10 Blair 1552 m to 1652 m (5090' to 5420')

Brown shales and gray claystones interbed with brown claystones to 1607 m (5270'). Brown claystones with small amounts of brown shales dominate the section to 1652 m (5420'). Low Resistivity is noted from the electric logs to 1650 m (5413'). The algal cyst, *Tytthodiscus sp.,* extending from the Jurassic to the top of the Late Miocene, late Mohnian [19], is noted in the sample at 5090-5420'. This confirms the late Mohnian age of this section. Other late Mohnian forms include *Nonion goudkoffi* [16:146] . The Radiolarian, *Prunopyle titan,* extends into the Late Miocene, early Delmontian [9, 10, 11, 20].

MONTEREY FORMATION (Low Resistivity), **Late Miocene, late Mohnian,** cont'd.

OTEC No. 1 Boyne 2149 m to 2232 m **(**7050 to 7320')

The well section examined from 2149 m (7050') to 2232 m (7320') was mainly a highly refractory brown shale. Very small amounts of gray shale were noted below 2149 m (7050'). The highly refractory brown shale is more prevalent in the Monterey than in other formations in this area. The top of the Monterey is placed here at 2149 m – 2158 m (7050-7080'), the appearance of *Sphaeroidinellopsis subdehiscens,* ranging world wide

LITHOSTRATIGRAPHIC UNITS/AGES, cont'd

from Pelagic Zone N13 to N17, ?N18 [8], and noted in California from the Late Miocene, late Mohnian, Monterey Formation [15:36]. Also found were specimens of the Late Miocene, early Mohnian to Delmontian, *Rotalia garveyensis* [16:149,17:97] at 2213 m – 2222 m (7260-7290').

L/H ELECTRIC LOG POINT, Low/High Resistivity e-log Marker in the Monterey Formation.

By correlating biostratigraphic data from all four wells studied, we are able to arrive at a relationship at the Low/High Resistivity (L/H) e-log point. This allows us to place the sections studied in the late Miocene, late Mohnian, Low Resistivity Monterey or the late Miocene, early Mohnian, High Resistivity Monterey Formation. The e-log points are as follows:

CABOT No. 1 Ferrero-Hopkins: 3840 m (12595') based on e-log pick
SUN No. 5 Blair: 3434 m (11230') based on e-log pick
TRITON No. 10 Blair: 1650 m (5413') based on e-log pick
OTEC No. 1 Boyne: No E-Log reached this point. Well stuck above it.

MONTEREY FORMATION (High Resistivity), **Late Miocene, early Mohnian**

TRITON No. 10 Blair 1652 m – 1863 m (5420-6110') Last Sample Examined

In the sample at 1652 m – 1662 m (5420-5450'), the Late Miocene, early Mohnian [16:151] foraminifer, *Virgulina ticensis,* has its top occurrence in this well. Just above this point, at 1650 m (5413'), the top of the High Resistivity section of the Monterey was noted. In the sample at 1744 m – 1753 m (5720-5750'), the brown shale yielded a richer fauna than noted elsewhere in the well. However, many forms were noted previously, and could be cavings. This is prevalent in this well. The next sample, 1753 m – 1762 m (5750-5780'), yielded a marker foraminifer, *Nonion medio-costatum,* ranging from middle Miocene, early Relizian, to late Miocene, early Mohnian [16:146]. The last sample examined at 1863 m (6110') in Triton No. 10 Blair was still in this lithic unit.

OTEC No. 1 Boyne 2232 m to 2527 m **(**7320' to 8290')

We place the top of the early Mohnian portion of the Monterey Formation, at 2232 m – 2241 m (7320-7350'), at the appearance of *Virgulina ticensis,* a species limited to the Late Miocene, early Mohnian [16:151]. A marker not found below the Mohnian [16:150] is *Uvigerina modeloensis*, identified in the sample at 2488 m – 2497 m (8160-8190'). The section from 2232 m to 2527 m (7320' to 8290') is a very monotonous

LITHOSTRATIGRAPHIC UNITS/AGES, cont'd
Interval of a highly refractory brown shale. There are traces of a gray shale seen sporadically throughout the section, but not nearly as much as the high percentages noted in the Sisquoc, above.

AGE INDETERMINATE, FORMATION INDETERMINATE
SUN No. 5 Blair, 3412 m to 3686 m (11190' to 12090')

The lithology is mainly a brown shale, with a tan claystone bearing a coating in samples from 11280' to 12090'. Many samples bore traces (5±%) of sands. Please see Lithology, below, Appendix D, p.101. Very few fossils found in this section. No index fossil was found.

Samples taken below 12090' [18] in SUN No. 5 Blair:

MONTEREY FORMATION, **Late Miocene, probably early Mohnian,**

In the Sun 5 Blair sample at 3686 m – 3695 m (12090-12120'), processing for Diatoms, the age-diagnostic Diatom, *Stephanogonia hanzawae* was found in the sample. This form is restricted to the late Miocene, Mohnian, Stage [1], and is plotted on the Range Chart for this section. We are still placing this sample as probably early Mohnian because of its juxtaposition to 3704 m – 3713 m (12150-12180'), as there is no proof of a later age.

Sample 3695 m – 3704 m (12120-12150') was examined only for Palynology, the study of spores and pollen, but no palynomorphs were noted.

Sample 3704 m – 3713 m (12150-12180') was then processed for Palynology with positive results. Sample 3704 m – 3713 m (12150-12180') was processed and examined for Paleontology, Diatoms (and Radiolaria), Palynology and Palynofacies. The results of the examination for Diatoms, Palynology and Paleontology are listed in the Stratigraphic Report, Appendix A, pp. 44-46, Fossil Distribution Chart, Appendix E, Plate 2, p.112, and the Range Chart, Appendix C, p. 96.

The Range Chart (p. 96 below) revealed that in the sample 3686 m-3695 m (12090-12120') the marker diatom *Stephanogonia hanzawae* is found in the late Miocene Mohnian [1].

The Range Chart also revealed the following forms in sample 3704 m – 3713 m (12150-12180') which died out at the end of the late Miocene, early Mohnian:

Bolivina aff hughesi	Early Mohnian to early l. Mohnian [16, 19]
Denticulina lauta	Late Luisian to early Mohnian [3, 4, 21]
Suggrunda californica	Early Mohnian [16]
Rotalia becki	Early Mohnian (Pseudosaucesian) [5]
Buliminella ecuadorana	Late Luisian to early Mohnian [19]

LITHOSTRATIGRAPHIC UNITS/AGES, cont'd

In the sample at 3704 m – 3713 m (12150-12180') we also found the following forms which first appear in the late Miocene, early Mohnian:

Globoquadrina humerosa	Early Mohnian to early Pleistocene [8, 9]
Picea sp.	Early Mohnian to Recent [9, 19]
Meliosira biseriata	Early Mohnian to Recent [4]
Dossetia lacera	Early Mohnian to Delmontian [9]
Cibicides illingi	Mohnian [16]

In the well SUN No. 5 Blair, Mr. Frank Getz notes that the Low-High Resistivity point was at 3424 m (11230'). The interval examined for the DOE, from 3412 m (11190') to 3695 m (12090'), fell into the high resistivity Monterey section without any markers. We had to rely on work done in 1993 [19] to use the results we have listed above.

MONTEREY FORMATION (High Resistivity), **Late Miocene, early Mohnian**

CABOT No. 1 Ferrero-Hopkins

The data collected from the thirteen lithic and paleontological samples examined from the Cabot No. 1 Ferrero-Hopkins well yielded information as to their lithic units, their ages and their environments of deposition. Both the lithology and the fossil content of the samples provided data. The presence of three pelagic forms, two age-diagnostic Radiolaria, *Prunopyle titan* and *Axoprunum angelinum,* and one age-diagnostic Diatom, *Glyphodiscus stellatus,* supplied key forms leading to the results found. See Correlation Chart, Appendix B, page 92, below, the Range Chart, Appendix C p. 95, below, the Lithologic Chart, Appendix D, p. 103, and the Fossil Distribution Chart, Appendix E, p. 111. Reference numbers in brackets [ ] refer to the numbered references in "References," p. 21, below.

IN MONTEREY FORMATION (High Resistivity), **Late Miocene, early Mohnian, CABOT No. 1 Ferrero-Hopkins,** 3918 m – 4032 m, TD (12850-13225' TD).

Brown shales and tan claystones dominate the section.. A trace of a gray siltstone appears from 3991 m to 4018 m (13090' to 13180'). Traces of very fine to medium grained sand are present throughout most of the section examined . The radiolarian, *Prunopyle titan,* starts in the Luisian, extends through the Mohnian into the Late Miocene, early Delmontian [10, 11, 12, 27], and appears as noted in these samples. A radiolarian, *Axoprunum angelinum,* ranging from the middle through the late Miocene, [1, 22] is present from 3972 m to 3991 m (13030' to 13090'). The diatom, *Glyphodiscus stellatus,* appearing in one sample, 4018 m – 4027 m (13180-13210') also ranges from the middle to late Miocene [1]. All three forms occur in the late Miocene, early Mohnian, and are present in the High Resistivity Monterey Formation.

ENVIRONMENTS OF DEPOSITION

The presence or absence of faunal and floral units reveal much information as to the type of environments in which these sediments were deposited. The ability to be able to discern the environments of deposition provides us with a tool that gives us clues as to whether we are drilling up slope or down slope from a potential reservoir. Usually drilling up slope from a deep water deposit into a higher energy rock may indicate more porosity. In the case of where we are drilling here in a deep water, highly refractory shale, we look for porosity in the fracture zones. Here, fracture zones are associated with faulting. We have a number of faults in the OTEC No. 1 Boyne well, making for abundant fracture zones.

Much of the environmental data has been taken from many sources including Barker [2], Ingle [15] and Loeblich [18], as well as unpublished studies by the writer.

CABOT 1 Ferrero-Hopkins

The lithologies are mainly medium to medium light shales, with 5 to 10 percent tan clays and 3 percent sands, silty to fine and medium grained, micaceous. We observe the majority of Pelagics on the Fossil Distribution Chart, Appendix E, p. 111. This allows us to believe that we are looking at Open Marine sediments with some higher energy sands, shell fragments and coal (at 13000-13030') perhaps washed in as turbidites.

SUN 5 Blair

Noting the preponderance of deeper marine forms in samples below 3686 m (12090') on the Fossil Distribution Chart, Appendix E, Plate 3, p.112, allow us to believe that the Middle Neritic to Bathyal foraminifers observed point to deeper water. As shallower species can be washed into deeper sediments by gravity, we assume that we are looking at deeper marine waters.

The lithologies noted were mainly a brown, shale and a tan claystone. Traces of sand from 3430 m (11250') continue to 3686 m (12090'). Below 3686 m (12090') [19] we noted shales, but no sands. There was some calcareous reaction. The species observed in sample 3704 m – 3683 m (12150-12180') indicate a Deep Marine, probably Bathyal, environment of deposition.. Such Outer Neritic forms as *Cassidulina sp.* and *Suggrunda californica* and Bathyal forms as *Rotalia becki,* plus a good percentage of pelagic forms suggest that the interval below 3686 m (12090') was deposited in Open Deep Marine, probably Bathyal waters. As many species confined to shallower waters are carried under normal conditions by gravity flows into deeper waters, we can assume that we encounter deeper water sediments in the interval studied.

TRITON 10 Blair

Noting the preponderance of darker blues and darker grays on the Fossil Distribution Chart, Appendix E, p. 114, allow us to believe that the Outer Neritic to Bathyal foraminifers found point to deeper water. As shallower species can be washed into deeper sediments by gravity, we assume that we are looking at deeper marine waters.

ENVIRONMENTS OF DEPOSITION, cont'd

The lithologies noted were mainly a brown, diffriable claystone and a brown diffriable shale. A small amount of limestone appears at 1671 m (5480') and continues to the sample at 1844 m – 1854 m (6050-6080'). A brown, friable mudstone dominates the samples from 1771 m (5810') down to 1863 m (6110'), last sample examined. The algal cyst, *Tytthodiscus sp*.; the diatoms, *Coscinodiscus symbolophora, Coscinodiscus sp.* and others; the radiolarians *Spongodiscus sp, Prunopyle titan, Calocyclas margatensis, Heliosphaera sp.* and *Spongurus spp.*; as well as the pelagic foraminifers, including *Globigerina cf bulloides* and others indicate Open Marine conditions. The foraminiferal deep water species include a few Outer Neritic forms such as *Virgulina ticensis, Virgulina delmonteensis* and others; Upper Bathyal forms include *Pullenia sp, Bulimina montereyana, Bulimina spp., Uvigerina spp.*; and Middle Bathyal forms are represented by *Sigmoilina sp, Gyroidina soldanii rotundimargo* and *Gyroidina spp.* As many species confined to shallower waters are carried under normal conditions by gravity flows into deeper waters, we can assume that we encounter deeper water sediments in the interval studied. The last sample examined, 1854 m – 1863 m (6080-6110'), however, contains only a form that is found in shallower water. This may indicate a change to shallower conditions. As no deeper samples were examined, we can not surmise any change.
Please see the data displayed on the Environmental Distribution Charts, Appendix F, Plate 7, p. 125 and the Paleo-Environmental Chart, Appendix B p. 93. It appears that the Low Resistivity Monterey section, from 1552 m to 1652 m (5090' to 5420') was deposited in deeper waters than the High Resistivity Monterey section from 1652 m to 1863 m (5420' to 6110'), last sample examined.

OTEC 1 Boyne
The lithologies noted were mainly a brown refractory shale, and in lesser percentages, a gray shale, clays washed out of sample, mudstones, siltstones, limestones, sandstones and sands. Although small in percentages, most sands were silty to fine, with coarse to very coarse grain size found at 2122 m to 2140 m (6960' to 7020'), 2149 m – 2158m (7050-7080'), 2277 m – 2286 m (7470-7500'), 2479 m – 2482 m (8130-8140') and 2527 m - 2528 m (8290-8293'). Coarser sands indicate higher energy deposition and higher porosity. Calcareous material (limestone) was noted sporadically throughout the section studied, with the greatest percentages between 2067 m (6780') and 2094 m (6870'). Non-marine influences could be caused by nearness to steep submarine cliffs (consequently near-shore) with non-marine plants being carried out by rip-tides to deeper waters. Much research involving many articles with thousands of taxa all over the world has allowed us to make the following estimates:

The radiolarians *Prunopyle titan* and *Spongodiscus sp.* as well as the pelagic foraminifer *Sphaeroidinellopsis subdehiscens* indicate Open Marine waters. Marine with Non-marine influences with wood fragments were noted at 2177 m – 2186 m (7140-7170') and from 2314 m to 2387 m (7590' to 7830'), containing plant roots (pyritized), plant fragments,

ENVIRONMENTS OF DEPOSITION, cont'd

seed pods, wood fragments and coal. The Benthic, Outer Neritic foraminifer *Virgulina ticensis* was noted at 2232 m – 2241 m (7320-7350') and *Virgulina grandis* at 2396 m – 2405 m (7860-7890') and 2499 m – 2506 m (8190-8220'). Marine Outer Neritic to Bathyal waters were seen with the foraminifer *Bulimina montereyana.*at 2213 m – 2222 m (7260-7290'). The sample at 2488 m – 2497 m (8160-8190') contained the Marine Upper Bathyal foraminifer *Uvigerina modeloensis*. The Middle Bathyal *Sigmoidella* was noted at 2104 m – 2113 m (6900-6930'). Please see Environmental Summary Chart, Appendix F, p. 124.

Paleo-Environmental Chart. Appendix B, Figure 3, p. 93, compares similar sections in the four wells, CABOT 1 Ferrero-Hopkins, SUN 5 Blair, TRITON 10 Blair and OTEC 1 Boyne. From the left, there is a column indicating the distance above or below the L/H Resistivity point. The four wells are hung on the L/H point, either above or below it. Well samples from Cabot 1 Ferrero-Hopkins and SUN 5 Blair run from their L/H point down to the bottom of the intervals examined.

With very few markers, the CABOT 1 Ferrero-Hopkins has a majority of Pelagic forms, indicating an Open Marine, probably deep water environment. Below the L/H point, the SUN 5 Blair has markers, both age-wise and environment-wise, indicating Upper and Middle Bathyal waters.[19].

The other two wells, TRITON 10 Blair and OTEC 1 Boyne straddle the L/H marker. TRITON 10 Blair has a short late Miocene, late Mohnian section that we interpret as Low Resistivity Monterey (see above, p. 11). There is a longer TRITON 10 Blair section below the L/H marker, which we consider the late Miocene, early Mohnian High Resistivity Monterey (see above, p. 11). OTEC 1 Boyne also has a section above the L/H marker and a section below the L/H marker, corresponding to the Low Resistivity Monterey (late Mohnian) and the High Resistivity Monterey (early Mohnian). We can not help but notice the similarities between the two depth curves above the L/H markers in the TRITON 10 Blair and the OTEC 1 Boyne. There are similarities in the High Resistivity sections besides; however there may be other factors, such as faulting, in the OTEC 1 Boyne well.

CONCLUSIONS

Mr. Frank Getz, chose key intervals in four wells, testing the Low Resistivity Monterey and the High Resitivity Monterey Formation intervals found in those wells. Mr. Getz and the writer did not know the age or what part of the Monterey we would be examining. Only by processing and analyzing samples from these wells would we know for sure. All four wells, CABOT No. 1 Ferrero-Hopkins, SUN No. 5 Blair, TRITON No.10 Blair, and the OTEC No. 1 Boyne, drilled while the DOE grant was being processed, provided information on the stratigraphic positions that were noted in these wells.

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CONCLUSIONS, cont'd

- Paleontology. By using Paleontology, we were able to correlate from known sections to unknown ones, and find similar hydrocarbon-productive zones noted in the known sections and in unknown intervals. This was important in the well TRITON No. 10 Blair and well OTEC No.1 Boyne, which has a section. that lacked electric logs due to hole problems. By using Paleontology, we wee able to set up sequences of fossils for age dating.

  We determined the stratigraphic positions of the Low Resistivity Monterey Formation and the High Resistivity Monterey Formation. We found that the Low Resistivity Monterey was late Miocene, late Mohnian, in age. A total of 9 index fossils were markers for the late Miocene, late Mohnian. Please see Range Charts, Appendix C, pages 94 - 99. Both the TRITON No. 10 Blair and the OTEC No. 1 Boyne contained sections with late Miocene late Mohnian fossils. Please see Fig. 1, Neogene Zones, Appendix B p. 91. Please see above, pp. 10, 11.

  Below the late Mohnian, Low Resistivity Monterey is the early Mohnian-aged High Resistivity Monterey productive zone. This is determined by examining the electric logs taken at the well site. We found early Mohnian fossils in the well sections corresponding to the High Resistivity Monterey Formation. A total of 8 index fossils were markers for the late Miocene, early Mohnian. Please see Range Charts, Appendix C, pp. 95 - 99 . The CABOT No. 1 Ferrero-Hopkins, the SUN No. 5 Blair, the TRITON No. 10 Blair and the OTEC No. 1 Boyne contained sections with late Miocene, early Mohnian, fossils. Please see above, pp.11 to 13. In many cases, the highest occurrence of early Mohnian forms determines the position of the High Resistivity Monterey Formation. In the OTEC No. 1 Boyne well, no electric log could be run lower than 1555 m (5100').

- Paleo-Environments, Interpreting Paleo-Environments enables us to determine water depths of the rock samples examined. Both Benthic (bottom dwellers) and Pelagic (floating specimens) provided age and environment information to find more oil. The majority of Shallow Water Benthic animals die not far from where they lived, as is the case with deeper forms. This was significant in the well OTEC No. 1 Boyne,.where no electric logs were run below 1555 m (5100'). The use of paleo-environment charts enable us to correlate one well section with another on the basis of their fluctuations in water depths. Please see Paleo-Environmental Chart, Appendix B, Fig. 3, p. 93.

- Lithology. By studying and plotting the rock characteristics of well samples, their Lithology, we were able to determine rock characteristics of formations as well as determining the ages of the sediments. We noted that the Sisquoc Formation con-

CONCLUSIONS, cont'd

tains gray shales in sufficient quantities to stand out when examined. This became important in the well OTEC No. 1 Boyne, where we identified the Sisquoc Formation through both lithology and fossils. Please see page 10, above.

PROJECT OBJECTIVES

MAIN OBJECTIVE

The main objective of this study was to establish an age zonation containing biohorizons that can be used in the Blair/Barham Ranch and the Los Alamos Fields, Santa Maria Area, Santa Barbara County, Californkia, as a standard for future drilling. Operators in this area can use this sequence of fossils:

- to determine which fossils can be found above, within and below reservoirs
- to apply to the reservoirs
- to map on this sequence
- to reduce costs
- to reduce risks
- to reduce environmental concerns resulting from less knowledgeable drilling.
- to increase production

OTHER OBJECTIVES

Other objectives are to prepare a number of papers illustrating the uses of this method.

- to refine structural concerns
- to refine reservoir rock considerations
- to get a better handle on the trapping mechanisms not only in this area, but in other areas for hydrocarbon exploration.

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LIST OF ACRONYMS AND ABBREVIATIONS

A. Abundant (33 to 120 specimens
C. Common (9 to 32 specimens)
F. Few (5 to 8 specimens)
FL. Flood (over 2000 specimens)
KB. Kelly Bushing, a measuring point in determining well depth
m. Meters
R. Rare (2 to 4 specimens)
Rge. Range. A six-mile spacing east or west of a geodetic base or meridian.
Sec. Section, referring to geodetic mile-square sections used in well locations.
TD. Total Depth of a well. The deepest point a well has penetrated.
Tsp. Township, a set of 36 sections north or south of a geodetic base or meridian.
VA. Very Abundant (121 to 2000 specimens)
X. Very Rare (1 specimen)
* Age-diagnostic Index Fossil
# Environmental Indicator

APPENDIX A

STRATIGRAPHIC REPORTS

MARKS AND ASSOCIATES

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****

STRATIGRAPHIC REPORT

DATE	: 23 June 2005	ACC. NO.	: 0162
WORKED BY	: E. Marks	AREA	: Sta. Maria
CLIENT	: F. Getz	LOC.	: Rcho. Los Alamos Fd
OPERATOR	: CABOT	COUNTY	: Sta. Barbara
WELL	: No. 1 Ferrero-Hopkins	STATE	: Californi
ELEVATION	: KB 934'	T.D.	13225'
SECTION	: 1 TSP 7N / RGE 33W, SBB&M		

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

12850-12880' Age Late Miocene Possibly Mohnian **Open Marine**
0162-1 **(Probably High Resistivity Monterey Fm.)**
Full sample **86% Shale**, medium to medium light brown, fissile, friable to diffriable, siliceous;
5% Clay, light tan, soft, friable, siliceous;
First Sample Examined **3% Sand,** white, quartzose, silty to medium grained, loose, milky to clear;
1% Mica, biotite;
5% Limonite;
3% Bit polish;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Wood
Wood Fragments, bn tn **R**

12880-12910'
0162-2 **75% Shale**, medium to medium light brown, fissile, friable to diffriable,
7/8 sample siliceous;
5% Clay, light tan, soft, friable, siliceous;
3% Sand, white, quartzose, silty to fine grained, loose, milky to clear;
1% Mica, biotite;
3% Limonite;
1% Pyrite;
3% Bit Polish;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: Radiolaria
Prunopyle titan *** X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

12910-12940' Age: L. Miocene, Poss. E. Mohnian (H.R. Monterey) Open Marine

0162-3 **94% Shale**, medium to medium light brown, fissile, friable to diffriable,
Full Sample siliceous;
5% Clay, light tan, soft, friable, siliceous;
1% Mica, biotite;
Bit Polish FE
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: Radiolaria
Prunopyle titan * **X**
Radiolaria spp **R**
Mollusca
Molluscan shell fragment **R**

12940-12970'

0162-4 **86% Shale**, medium to medium light brown, fissile, friable to diffriable,
Full Sample siliceous,white inclusions;
10% Clay, light tan, soft, friable, siliceous;
3% Sand, white, quartzose, silty to fine grained, angular to subangular,
loose, milky to clear;
1% Mica, Biotite;
Bit polish R
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: Radiolaria
Radiolaria spp **R**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

12970-13000' Age: L. Miocene, Poss. E. Mohnian (H.R. Monterey) Open Marine

0162-5 **91% Shale**, medium to medium light brown, fissile, friable to hard,
Full Sample siliceous,white inclusions;
5% Clay, light tan, soft, friable, siliceous;
3% Sand, white, quartzose, silty to very fine grained, angular to subangular, loose, milky to clear;
1% Mica, Biotite;
Bit polish R
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: Radiolaria
Radiolaria spp **X**

13000-13030' 90% Shale, medium to medium light brown, fissile, friable to hard,
0162-6` siliceous,white inclusions;
Full Sample **5% Clay**, light tan, soft, friable, siliceous;
3% Sand, white, quartzose, silty to fine grained, angular to subangular, loose, milky to clear;
1% Mica, Biotite;
1% Limonite;
Bit polish R
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Coal **X**
Diatoms
Coscinodiscus **X**
Animal: Radiolaria
Prunopyle titan * **R**
Radiolaria spp **R**
Foraminifera
Haplophragmoides spp **R**
Uvigerinella sp **X**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

13030-13060' Age: L. Miocene, Poss. E. Mohnian (H.R. Monterey) Open Marine

0162-7 **78% Shale**, medium to medium light brown, fissile, friable to hard,
7/8 Sample siliceous,white inclusions;
5% Clay, light tan, soft, friable to diffriable, siliceous;
3% Sand, white, quartzose, silty to medium grained, angular to subrounded, loose, milky to clear;
1% Mica, Biotite;
1% Limonite;
Bit polish R
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Diatoms
Coscinodiscus sp **X**
Wood fragments bn tn **R**
Animal: Radiolaria
Axoprunum angelinum *** X**

13060-13090'

162-8 **77% Shale**, medium to medium light brown, fissile, diffriable to hard,
7/8 Sample siliceous, white inclusions;
5% Clay, light tan, soft, friable, siliceous, 5% coating on shale fragments;
3% Sand, white, quartzose, silty to fine grained, angular to subrounded, loose, milky to clear;
3% Mica, Biotite;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Algal cyst **X**
Animal: Radiolaria
Axoprunum angelinum *** X**
Foraminifera
Haplophragmoides sp **R**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
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FE=Few (5-8)
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SAMPLE #.	SPECIES, ABUNDANCE, AGE, FORMATION	ENVIRONMENT
13090-13120'	**Age: L. Miocene, Poss. E. Mohnian (H.R. Monterey)**	**Open Marine**
0162-9	**86% Shale**, medium to medium light brown, fissile, diffriable to hard, siliceous, white inclusions;	
Full Sample	**5% Clay**, light tan, friable to diffriable, siliceous, coating on shale fragments;	
	3% Sand, white, quartzose, silty to fine grained, angular to subangular, loose, milky to clear;	
	1% Siltstone, light gray, quartzose, silty grained, friable to diffriable;	
	5% Mica, Biotite;	
	Bit polish R	
	No Clay washed out of sample;	
	NO OIL FLUORESCENCE.	
	Animal: Radiolaria	
	Radiolaria sp **R**	
13120-13150'	**85% Shale**, medium to medium light brown, fissile, diffriable to hard, siliceous;	
0162-10		
Full Sample	**5% Siltstone,** light gray, quartzose, silty grained, angular, friable to diffriable; milky to clear, siliceous cement;	
	3% Clay, light tan, friable to diffriable, siliceous, coating on shale fragments;	
	3% Sand, white, quartzose, silty to very fine grained, angular to subangular, loose, milky to clear;	
	3% Mica, Biotite;	
	1% Limonite;	
	Bit polish R	
	No Clay washed out of sample;	
	NO OIL FLUORESCENCE.	
	Animal: Radiolaria	
	Radiolaria sp **R**	

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R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE, FORMATION	ENVIRONMENT
13150-13180'	**Age: L. Miocene, Poss. E. Mohnian (H.R. Monterey)**	**Open Marine**
0162-11	**91% Shale**, medium to medium light brown, fissile, diffriable to hard,	
Full Sample	siliceous; white inclusions;	
	3% Clay, light tan, soft, friable, siliceous, coating on shale fragments;	
	3% Sand, white, quartzose, silty to fine grained, angular to subangular, loose, milky to clear;	
	5% Siltstone, light gray, quartzose, silty grained, angular, friable to diffriable; milky to clear, siliceous cement;	
	1% Mica, Biotite;	
	1% Limonite;	
	Bit polish R	
	No Clay washed out of sample;	
	NO OIL FLUORESCENCE.	
	Animal: Radiolaria	
	Radiolaria sp **R**	
13180-13210'	**83% Shale**, medium to medium light brown, fissile, diffriable to hard,	
0162-12	siliceous; white inclusions;	
7/8 sample	**3% Clay**, light tan, friable to diffriable, siliceous, 5% coating on shale fragments;	
	3% Sand, white, quartzose, silty to very fine grained, angular to subangular, loose, milky to clear;	
	1% Limonite;	
	Bit polish R	
	12% Clay washed out of sample;	
	NO OIL FLUORESCENCE;	
	Plant: Diatom	
	Glyphodiscus stellatus * **X**	
	Animal: Radiolaria	
	Radiolaria sp **R**	

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
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SAMPLE #.	SPECIES, ABUNDANCE, AGE, FORMATION	ENVIRONMENT
13210-13225'	**Age: L. Miocene, Poss. E. Mohnian (H.R. Monterey)**	**Open Marine**
0162-13	**85% Shale**, medium to medium light brown, fissile, diffriable to hard,	
Full Sample	**10% Clay**, light tan, soft, friable, siliceous, 5% coating on shale	
Total	fragments;	
Depth	**3% Sand,** white, quartzose, silty to very coarse grained, angular to subrounded, loose, milky to clear;	
	1% Mica, Biotite;	
	1% Limonite;	
	Bit polish FE	
	No Clay washed out of sample;	
	NO OIL FLUORESCENCE.	
	Plant: Diatom	
	Coscinodiscus sp **X**	
	Animal: Radiolaria sp **R**	
	Spongodiscus sp **X**	

MARKS AND ASSOCIATES

5964 FIJI STREET, CYPRESS, CALIFORNIA 90630
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STRATIGRAPHIC REPORT

DATE : 13 December, 2004 ACC. NO. : 0161
WORKED BY : E. Marks AREA : Sta. Maria
CLIENT : F. Getz LOC. : La Laguna. Fd.
OPERATOR : SUN EXPLORATION & PRODUCTION COUNTY : Sta. Barbara
WELL : NO. 5 BLAIR STATE : California
ELEVATION : KB 1038.5‘ T.D. 12,500’
SECTION : 4, TSP 7N / RGE 32W SBB & M

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

11,190-11,220’

161-1 **67% Shale**, medium to medium light brown, fissile, diffriable to hard, siliceous;
¾ sample **3% Mica Biotite;**
First Sample **5% Limonite;**
examined **25% Clay washed out of sample;**
NO OIL FLUORESCENCE.
Plant: Plant fiber brown **X**
Animal: Fish Bone Frags **R**
Fish Scale Frags **R**
?Foraminifera **R**
Molluscan shell fragments **?R**
SPORBO **R**

11220-11250’

161-2 **95% Shale**, medium to medium light brown, fissile, diffriable to hard, siliceous;
Full sample **5% Limonite;**
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Plant fragments **X**
Animal: Fish Bone Fragments **X**
Foraminifera? **R**
Molluscan Shell fragments **?R**
SPORBO **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11250-11280'
161-3 **80% Shale**, medium to medium light brown, fissile, diffriable to hard,
7/8 sample siliceous;
3% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, friable to diffriable, milky to clear, clay cement;
5% Limonite;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Wood fragments bn,tan **X**
Animal: Fish Bone Fragments **X**
Foraminifera? **F**
Molluscan Shell Fragments **F**
SPORBO **X**

11280-11310' **80% Shale**, medium to medium light brown, fissile, diffriable to hard,
161-4 siliceous;
Full Sample **20% Claystone**, light tan, friable to diffriable, siliceous; also coating on shale fragments;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant : Plant fiber brown **X**
Wood Fragments bn tan **R**
Animal: Fish Bone Fragments **X**
Fish Scale Fragments **X**
Foraminifera? **C**
Molluscan Shell Fragments **F**
SPORBO **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11310-11340'
0161-5
¾ Sample

65% Shale, medium to medium light brown, fissile, diffriable to hard, siliceous;
5% Claystone, light tan, friable to diffriable, siliceous; also coating on shale fragments;
5% Limonite;
25% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Wood Fragments bn tan **X**
Animal: Fish Bone Fragments **X**
Foraminifera? **A**
Molluscan Shell Fragments **F**

11340-11370' **94% Shale**, medium to medium light brown, fissile, diffriable to hard, siliceous;
0161-6
Full sample **5% Claystone**, light tan, friable to hard, siliceous; also coating on shale fragments;
1% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, friable to diffriable, milky to clear, clay cement;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: Fish Bone Fragments **X**
Foraminifera? **A**
Molluscan Shell fragments **F**
SPORBO **X**

11370-11400' **94% Shale**, medium to medium light brown, fissile, diffriable to hard, siliceous;
0161-7
Full Sample **5% Claystone**, light tan, friable to hard, siliceous; also coating on Shale fragments;
1% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, friable to diffriable, milky to clear, clay cement;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: Foraminifera? **A**
Molluscan Shell fagments **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11400-11430'
0161-8 **96% Shale**, medium to medium light brown, fissile, diffriable to hard,
Full Sample siliceous;
3% Claystone, light tan, friable to hard, siliceous; also coating on Shale fragments;
1% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, friable to diffriable, milky to clear, clay cement;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Wood Fragments bn, tan **X**
Animal: Fish Bone Fragments **X**
Foraminifera? **A**
Molluscan Shell fragments **X**
SPORBO **X**

11430-11460' **99% Shale**, medium to medium light brown, fissile, diffriable to hard,
0161-9 siliceous;
Full Sample **1% Claystone**, light tan, soft, friable, siliceous; also coating on shale fragments;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Wood Fragments bn, tn **X**
Animal: Fish Bone Fragments **X**
?Foraminifera **C**
Gastropod Shell Fragments **C?**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11460-11490'
0161-10 **96% Shale**, medium to medium light brown, fissile, diffriable to hard,
Full Sample siliceous;
3% Claystone, light tan, friable, siliceous; also coating on shale fragments;
1% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, friable to diffriable, milky to clear, clay cement;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Wood Fragments brn tn **X**
Animal: Fish Bone Fragments **X**
?Foraminifera **C**
Gastropod Shell Fragments **C**

11490-11520' 81% Shale, medium to medium light brown, fissile, diffriable to hard,
0161-11 siliceous;
7/8 sample **1% Sand,** white, quartzose, fine to medium grained, angular to subrounded, loose, milky to clear;
5% Limonite;
13% Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **C**
Gastropod Shell Fragments **A**

11520-11550' 64% Shale, medium to medium light brown, fissile, diffriable to hard,
0161-12 siliceous;
¾ Sample **5% Claystone**, light tan, friable, siliceous; also coating on shale fragments;
1% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, friable, milky to clear, clay cement;
5% Limonite;
25% Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **C**
Gastropod Shell Fragments **A**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11550-11580'
0161-13 **80% Shale**, medium to medium light brown, fissile, diffriable to hard,
7/8 Sample siliceous;
3% Clay, light tan, friable, siliceous; coating on shale fragments;
1% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, friable, milky to clear, clay cement;
3% Limonite;
13% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Wood Fragments bn, tn **X**
Animal: ?Foraminifera **C**
Gastropod Shell Fragments **C**

11580-11610' **68% Shale**, medium to medium light brown, fissile, diffriable to hard,
0161-14 siliceous;
¾ Sample **3% Clay**, light tan, friable, siliceous; coating on shale fragments;
1% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, loose, friable, milky to clear, clay cement;
3% Limonite;
25% Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**

11610-11640' **87% Shale**, medium to medium light brown, fissile, diffriable to hard,
0161-15 siliceous;
Full Sample **5% Clay**, light tan, friable, siliceous; coating on shale fragments;
3% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, loose, friable, milky to clear, clay cement;
5% Limonite;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11640-11670'
0161-16 **62% Shale**, medium to medium light brown, fissile, diffriable to hard,
3/4 Sample siliceous;
5% Clay, light tan, friable, siliceous; coating on shale fragments;
3% Sand, white, quartzose, fine to coarse grained, angular to subrounded, loose, milky to clear;
5% Limonite;
25% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Plant fiber brown **X**
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**

11670-11700' **81% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
0161-17 **3% Clay**, light tan, friable, siliceous; coating on shale fragments;
7/8 Sample **3% Sand,** white, quartzose, fine to very coarse grained, angular to subrounded, loose, milky to clear;
1% Limonite;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Plant fiber brown **X**
Animal: ?Foraminifera **C**
Gastropod Shell Fragments **C**

11700-11730` **82% Shale**, medium to medium light brown, fissile, diffriable to hard,
0161-18 siliceous;
7/8 Sample **3% Clay**, light tan, friable, siliceous; coating on shale fragments;
3% Sand, white, quartzose, fine to very coarse grained, angular to subrounded, loose, milky to clear;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Plant fiber brown **X**
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**

-

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11730-11760'
0161-19 **60% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
¾ Sample **10% Clay**, light tan, friable, siliceous, 40% coating on shale fragments;
5% Sandstone, white, gray, quartzose, silty to coarse grained, angular to subrounded, loose, friable to diffriable, milky to clear, siliceous cement;
25% Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**

11760-11790' **90% Shale**, medium to light brown, fissile, friable to diffriable, siliceous;
161-20 **5% Claystone**, light tan, friable to diffriable, siliceous; coating on shale
Full Sample fragments;
5% Sandstone, white, gray, quartzose, silty to coarse grained, angular to subrounded, loose, friable to diffriable, milky to clear, siliceous cement;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**

11790-11820' **70% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
161-21 **5% Claystone**, light tan, friable to diffriable, siliceous; coating on shale
7/8 Sample fragments;
5% Sandstone, white, grey, quartzose, fine to coarse grained, angular to subrounded, friable to diffriable, milky to clear;
5% Limonite;
15% Clay washed out of sample;
NO OIL FLUORESCENCE..
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11820-11850'
0161-22 **91% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
Full Sample **5% Claystone,** light tan, friable to hard, siliceous, coating on shale fragments;
1% Sandstone, white, quartzose, medium to coarse grained, subangular to subrounded, loose, milky to clear;
3% Limonite;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**
SPORBO **R**

11850-11880' **89% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
0161-23 **5% Claystone,** light tan, friable, siliceous, coating on shale fragments;
Full Sample **1% Sandstone,** white, quartzose, fine to medium grained, subangular to subrounded, loose, milky to clear;
5% Limonite;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **C**
Gastropod Shell Fragments **C**
SPORBO **F**

11880-11910' **93% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
0161-24 **3% Claystone,** light tan, friable, siliceous, coating on shale fragments;
Full Sample **1% Sandstone,** white, quartzose, fine to medium grained, subangular to subrounded, loose, milky to clear;
3% Limonite;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Plant fiber brown **X**
Animal: ?Foraminifera **F**
Gastropod Shell Fragments **C**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

11910-11940'
0161-25 **75% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
Full Sample **20% Claystone,** light tan,, friable, siliceous, coating on shale;
5% Limonite;
No Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: **?**Foraminifera **?R**
Gastropod Shell Fragments **?C**

11940-11970' **79% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
161-26 **5% Claystone,** light tan, friable to diffriable, siliceous, coating on shale
7/8 Sample fragments;
3% Sandstone, white, gray, quartzose, fine to coarse grained, angular to subrounded, friable to diffriable, milky to clear, siliceous cement;
1% Limonite;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **R**
Gastropod Shell Fragments **C**

11970-12000' **81% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
0161-27 **5% Claystone,** light tan, friable to diffriable, siliceous, coating on shale fragments;
7/8 Sample **1% Sandstone,** white, grey, quartzose, very fine to coarse grained, angular to subrounded, loose, friable to diffriable, milky to clear, siliceous cement;
1% Limonite;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **X**
Gastropod Shell Fragments **C**

12000-12030' **85% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
0161-28 **3% Claystone,** light tan, friable to diffriable, siliceous;
7/8 Sample **12% Clay washed out of sample;**
NO OIL FLUORESCENCE.
Animal: ?Foraminifera **R**
Gastropod Shell Fragments C

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

12030-12060'
0161-29 **67% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
7/8 Sample **15% Claystone,** light tan, soft to friable, siliceous, loose, coating on shale fragments;
1% Sandstone, white, grey, quartzose, very fine to coarse grained, angular to subrounded, loose, friable to diffriable, milky to clear;
5% Limonite;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Plant fiber brown **R**
Animal: ?Foraminifera **R**
Gastropod Shell Fragments **C**

12060-12090' **79% Shale**, medium to light brown, fissile, diffriable to hard, siliceous;
161-30 **5% Claystone,** light tan, friable to diffriable, siliceous, loose, coating on
7/8 Sample shale fragments;
Last Sample **1% Sandstone,** white, grey, quartzose, very fine to coarse grained,
Examined angular to subrounded, loose, friable to diffriable, milky to clear;
3% Limonite;
12% Clay washed out of sample;
NO OIL FLUORESCENCE.
Plant: Plant fiber brown **R**
Animal: ?Foraminifera **R**
Gastropod Shell Fragments **C**

The following is excerpted from the report by E. Marks to Mr. Frank Getz, dated, 28 January 1993, RE: four samples from Sun No. 5 Blair, Sec. 4, T. 7 N., R 32 W., S.B.B. M., T.D. 12,500' [19]. Please note remarks by Dr. S. K.Srivastava included in report by E. Marks, 1993 (id.).

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT

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SAMPLE #.	**SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT**	
12090-12120'	**Age Late Miocene, probably early Mohnian**	**Pelagic**
901	**(Monterey Formation)**	**Deep Marine**
	Shale, dark to med. Brown, friable, fissile; 20% lt. crème, calcareous 5% diatoms, noted embedded in shale. Processed and examined for Diatoms Diatoms (lareger than 75 microns) Actinocyclus ingens VR Stephanogonia hanzawae * R Coscinodiscus sp. VR Palynomorph: Bisaccate conifer pollen VR Radiolaria (larger than 75 microns): Spongopyle osculosa FE Spongodiscus sp. VR	
12120-12150'	**Late Miocene, probably early Mohnian**	**Pelagic**
902	**(Monterey Formation)**	**Deep**
	Shale, dark to med. Brown, friable, fissile;	**Marine**
	20% lt. crème; 5% calcareous reaction; **bentonite**, lt. Tan Processed and examined for Palynology. No Palynomorphs present. Very little organic material recovered. A few grains of amorphous coaly material or small fragments of inertinite were present. (Srivastava, in Marks, 1993, 21)	

MARKS AND ASSOCIATES
STRATIGRAPHIC REPORT

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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

12150-12180' Late Miocene, early Mohnian Marine, Bathyal
903 (Monterey Formation) V. low energy

Shale, dark to med. brown, friable, fissile, 20% lt. crème;
20% calcareous reaction;
Processed and examined for Paleontology, Diatoms, Palynology, and Palynofacies:
Palynofacies:
10% Vitrinite, mostly amorphous
10% inertinite,:
5% large grains
40% medium grains
55% small grains
rounded to subrounded
80% sapropel:
50% small grains
50% amorphous
High physical degradation
No biological degradation
TAI: 2.75 (out of 5.0)
Plants
Palynomorphs:
Spinose cyst spore:
Dossetia lacera X
Fungal spore X
Onagraceae pollen X
Silicified Picea sp. X
Diatoms:
Meliosira sulcata var. biseriata R
Coscinodiscus sp. X
Denticula lauta X *
Animals
Fish bone fragments R
Sponge Spicules (tetract.) X

12150-12180' CONTINUED ON P. 46

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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SAMPLE #.	**SPECIES, ABUNDANCE, AGE, FORMATION**	**ENVIRONMENT**
12150-12180'	**Late Miocene, early Mohnian**	**Marine, Bathyal**
903	**(Monterey Formation)**	**V. low energy**
	(Continued from previous page)	
	Foraminifera:	
	Bolivina aff. hughesi FE *	
	Bolivina tumida R	
	Buliminella ecuadorana X *	
	Cassidulina sp. X	
	Cibicides illingi X *	
	Epistominella cf. Smithi X	
	Globoquadrine humerosa X	
	Hemicristellaria sp. X	
	Rotalia becki FE *	
	Suggrunda californica R *	
	Trochammina incertus R	
	Radiolaria:	
	Acrosphaera sp. X	
	Actinomma sp. FE	
	Prunopyle titan FE	
	Prunopyle sp. (round) X	
	Siphocampe nodosaria R	
	Spongopyle osculosa X	
	Theocorys redondoensis C	
12180-12210'	**Late Miocene, early Mohnian**	**Pelagic**
904	**(Monterey Formation)**	**Probably**
Last	**Shale**, dark to med, brown, friable, fissile;	**Deep Marine**
Sample	10% lt. Crème	
Examined	No calcareous reaction	
	Sample examined for lithic percentage only.	

MARKS AND ASSOCIATES

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STRATIGRAPHIC REPORT

DATE	: 12 October 2004	ACC. NO.	: 0160
WORKED BY	: E. Marks	AREA	: Sta. Maria
CLIENT	: F. Getz	LOC.	: Barham Rch. Fd.
OPERATOR	: Triton	COUNTY	: Sta. Barbara
WELL	: No. 10 Blair	STATE	: California
ELEVATION	: KB 872'	T.D	: 6389'
SECTION	: 3 T7N R32W SBB&M		

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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

5090-5120' IN Late Miocene l. Mohnian (low Resistivity Monterey) Open Marine

160-1 **Shale,** medium to medium light brown, fissile, friable to diffriable,
Full sample **5% Shale,** medium light to light gray, friable, to diffriable, siliceous;
First Sample **5% Claystone** , medium light to light gray, friable, siliceous;
examined **NO FLUORESCENCE.**
Slickensides X
Plant: Algae:
Tytthodiscus sp* # **X**
Animal: Radiolaria
Spongodiscus spp # **R**
Fish Bone Fragments **X**

5120-5150' 90% Shale, medium to medium light brown, fissile, friable to diffriable,
160-2 siliceous;
Full sample **5% Shale,** medium to light gray, friable, to diffriable, siliceous;
5% Claystone , medium light to light brown, friable, siliceous;
NO FLUORESCENCE.
Animal: Radiolaria:
Spongodiscus sp.# **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

5150-5180' Late Miocene, late Mohnian (Low Resistivity Monterey) Open Marine
160-3 **Claystone** , medium light to light brown, friable, siliceous;
Full Sample **20%**. **Shale**, medium to medium light brown, fissile, friable to diffriable, siliceous;
5% Shale, medium light to light gray, friable, to diffriable, siliceous;
NO FLUORESCENCE.
Animal: Radiolaria spp **X**
Foraminifera:
Bulimina montereyana **# R**
Elphidium cf tumidum **X**
Globigerina cf bulloides **# X**
Haplophragmoides spp **X**
Nonion goudkoffi *** R**
Trochammina spp **X**
Virgulina spp **# X**

5180-5210' **Shale**, medium to medium light brown, fissile, friable to diffriable;
160-4 siliceous;
Full Sample **10% Claystone** , medium to light gray, friable to diffriable, siliceous;
5% Shale, medium light to light gray, friable, to diffriable, siliceous;
NO FLUORESCENCE.
Slickensides R
Animal: Radiolaria:
Spongodiscus spp # **R**
Heliosphaera spp # **X**

5210-5240' **Shale**, medium to medium light brown, fissile, siliceous;
0160-5 **10% Claystone** , medium to light gray, friable to diffriable, siliceous;
Full Sample **5% Shale,** medium light to light gray, friable, to diffriable, siliceous;
3% Mica, Biotite;
NO FLUORESCENCE;
Plant: Diatoms **FE**
Animal: Radiolaria spp **# R**
Prunopyle titan* **# X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

5240-5270' Late Miocene, late Mohnian (Low Resistivity Monterey) Open Marine

0160-6 **Shale**, medium to medium light brown, fissile, friable to diffriable,
Full Sample siliceous, calcareous, very low Hydrochloric acid reaction;
10% Claystone , medium to light gray, friable to diffriable, siliceous**;**
3% Shale, medium to medium light gray, friable, to diffriable, siliceous;
NO FLUORESCENCE.
Slickensides R
Plant: Algal cyst? # **X**
Diatoms # **R**
Coscinodiscus symbolophora* # **R**
Animals: Radiolaria spp # **R**

5270-5300' **Shale**, medium to medium light brown, fissile, friable to diffriable,
0160-7 siliceous;
Full Sample **10% Claystone** , medium light to light grayish brown, friable;
5% Shale, medium light to light gray, , friable, to diffriable;
NO FLUORESCENCE.
SPORBO X
Slickensides R
Plant: Diatoms:
Coscinodiscus sp. # **X**
Animal: Radiolaria:
Spongodiscus spp.# **R**
Foraminifera:
Buliminella curta **X**
Virgulina spp # **X**

5300-5330' **Shale**, medium to medium light brown, fissile, friable to diffriable,
0160-8 siliceous;
Full Sample **20% Claystone** , medium light to light grayish brown, friable .siliceous;
3% Shale, medium light to light gray, friable, to diffriable, siliceous;
NO FLUORESCENCE
Plant: Algae:
Tytthodiscus sp *. # **X**
Animal: Foraminifera:
Virgulina cf ticensis # **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

5330-5360' Late Miocene, late Mohnian (Low Resistivity Monterey) Open Marine

0160-9 **Shale**, medium to medium light brown, friable to diffriable, siliceous
Full Sample **20% Claystone** , medium to light grayish brown, friable .siliceous
3% Limestone, medium light to light tan, , lenticular crème inclusions, hard, siliceous, calcareous, very low hydrochloric acid reaction;
1% Mica, Biotite;
NO FLUORESCENCE.
Slickensides FE
Animal: Foraminifera:
Cibicides sp. **X**
Rotaliid sp. **X**
Fish Bone Fagments **X**

5360-5390' **Shale**, medium to medium light brown, fissile, friable to diffriable, siliceous;
0160-10 **20% Claystone** , medium light to light grayish brown, friable .siliceous;
Full Sample **3% Limestone,** medium light to light tan, , lenticular crème inclusions, hard, siliceous, calcareous, very low hydrochloric acid reaction;
NO FLUORESCENCE.
SPORBO R
Slickensides FE
Plant: Diatoms:
Coscinodiscus spp # **R**
Coscinodiscus symbolophora * # **R**
Animal: Radiolaria spp # **R**
Calocyclas margatensis # **R**
Prunopyle titan * # **X**
Foraminifera:
Buliminella curta **X**
Rotalia spp **X**
Sponge spicule straight **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

5390-5420' Late Miocene, late Mohnian (Low Resistivity Monterey) Open Marine

160-11 **Shale**, medium to medium light brown, fissile, friable to diffriable,
Full sample siliceous;
30% Claystone , medium light to light grayish brown, friable to. diffriable, siliceous;
5% Limestone, medium light to light tan, lenticular crème inclusions,
, streaks, hard, siliceous, calcareous, very low hydrochloric acid reaction;
NO FLUORESCENCE;
Plant: Diatoms:
Coscinodiscus symbolophora* # **X**
Animal: Radiolaria:
Calocycyclas margatensis # **X**
Foraminifera:
Bolivina sp. **X**

5420-5450' TOP Late Miocene, early Mohnian (High Resistivity Monterey) Open Marine

160-12 **Shale**, medium to medium light brown, fissile, friable to diffriable,
Full Sample siliceous;
30% Claystone , medium light to light grayish brown, friable to diffriable, siliceous;
5% Limestone, medium light to light tan, crème streaks, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
3% Sand, white, quartzose, silty to very fine grained, angular to subangular, loose, milky to clear;
1% Mica, Biotite;
NO FLUORESCENCE;
Animal: Radiolaria:
? Prunopyle fragment. # X
Foraminifera:
Buliminellla curta **X**
Gyroidina spp indet**. # X**
Haplophragmoides sp **X**
Nonion goudkoffi **X**
Pullenia sp **# X**
Trochammina sp **X**
Virgulina ticensis *** # X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #. SPECIES, ABUNDANCE, AGE, FORMATION ENVIRONMENT

5450-5480' Late Miocene, early Mohnian (High Resistivity Monterey) Marine

160-13 **76% Claystone**, medium light to light grayish brown, friable to diffriable, siliceous,
Full Sample **10% Shale**, medium to medium light brown, fissile, friable to diffriable, siliceous;
5% Shale, medium light to light gray, fissile, friable to diffriable, siliceous;
5% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
1% Mica, Biotite;
3% Slickensides;
No Clay washed out of sample;
NO FLUORESCENCE;
SPORBO X
Plant: Wood Fragments tn **R**
Animal: Foraminifera:
Buliminella curta **X**
Buliminella elegantissima **X**
Eponides sp **R**
Gyroidina sp indet**.** # **R**

5480-5510' 50% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
0160-14
Full Sample **30% Shale**, medium to medium light brown, fissile, friable to diffriable, siliceous;
20% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
No Clay washed out of sample;
NO FLUORESCENCE.
Plant: Diatoms:
Coscinodiscus spp. # **R**
Animal: Radiolaria spp. # **R**
Foraminifera:
Buliminella curta **X**
Sphere, clear **X**

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SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5510-5540' Late Miocene, early Mohnian (High Resistivity Monterey) Marine

0160-15
Full Sample

40% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
40% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
20% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
No Clay washed out of sample;
NO FLUORESCENCE.

Plant: Radiolaria:
Coscinodiscus sp.# **X**

Animal: Foraminifera:
Nonion sp. indet**.** **X**
Rotalia garveyensis **R**

5540-5570'
0160-16
Full Sample

50% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
30% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
20% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
No Clay washed out of sample;
NO FLUORESCENCE.

Animal: Foraminifera:
Buliminella elegantissima **X**

5570-5600'
0160-17
Full Sample

70% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
20% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
10% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
No Clay washed out of sample;
NO FLUORESCENCE.

Plant: Diatoms:
Coscinodiscus symbolophora # **X**

Animal: Foraminifera:
Buliminella elegantissma **X**
Haplophragmiodes spp **X**
Nonionella davanaensis **R**
Polymorphina sp. **X**
Virgulina delmonteensis # **X**
Virgulina ticensis * # **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5600-5630' Late Miocene, early Mohnian (High Resistivity Monterey) Marine

0160-18 **70% Claystone**, medium light to light grayish brown, friable to diffriable**,** siliceous;
full sample **20% Limestone,** medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
10% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
No Clay washed out of sample;
NO FLUORESCENCE.
Plant: Diatoms **# X**
Animal: Foraminifera:
Haplophragmoides spp **R**
Rotalia garveyensis **X**
Rotaliid sp. **X**

5630-5660' **70% Shale**, medium to medium light brown, fissile, friable to diffriable,
0160-19 siliceous;
Full Sample **20% Limestone,** medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
10% Claystone, medium light to light grayish brown, friable to diffriable,siliceous;
No Clay washed out of sample;
FLUORESCENCE: Short Wave: LF in H2O; **Long Wave**: LF in H2O.
Plant: Diatoms:
Coscinodiscus sp. # **X**
Coscinodiscus symbolophora **# R**
Animal: Radiolaria sp # **X**
Spongodiscus sp.# **X**
Foraminifera RW **X**
Bulimina sp. indeterminate **# X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5660-5690' Late Miocene, early Mohnian (High Resistivity Monterey) Marine

0160-20 **69% Shale**, medium to medium light brown, fissile, friable to diffriable,
Full Sample siliceous;

15% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;

10% Claystone , medium light to light grayish brown, friable to diffriable, siliceous;

5% Mudstone, medium light brown, mottled, friable, siliceous, calcareous,very low hydrochloric acid reaction;

1% Mica, Biotite;

No Clay washed out of sample;

FLUORESCENCE: Short Wave: VLF in H2O; **Long Wave:** LF in H2O.

Animal: Foraminifera:

Bolivina sp fragment **R**
?Lagena sp. **X**
Nonion sp indeterminate **X**
Rotaliid sp **X**
Uvigerina sp indeterminate **# X**
Virgulina ticensis *** # X**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5690-5720' Late Miocene, early Mohnian (High Resistivity Monterey) Marine

0160-21 **74% Claystone**, medium to medium light brown, fissile, friable to
Full Sample diffriable, siliceous;

15% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;

5% Mudstone, medium light brown, mottled, friable, siliceous, calcareous,very low hydrochloric acid reaction;

5% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;

1% Mica, Biotite;

No Clay washed out of sample;

FLUORESCENCE: Short Wave: SF in H2O; **Long Wave:** LF in H2O.

Iron filings

Plant: Diatoms **X**

Algae:

Tytthodiscus sp # **X**

Animal: Radiolaria sp # **R**

Spongodiscus sp # **R**

?Foraminifera **X**

Buliminella subfusiformis **X**

Globigerina sp # **X**

Haplophragmoides sp **R**

Nonion goudkoffi **X**

Nonion montereyanum **R**

Virgulina sp indeterminate # **X**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5720-5750' **Late Miocene, early Mohnian (High Resistivity Monterey) Marine**

0160-22 **80% Claystone**, medium light to light grayish brown, friable to
Full Sample diffriable, siliceous;

10% Mudstone, medium light brown, mottled, friable, siliceous, calcareous, very low hydrochloric acid reaction;

5% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;

5% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;

No Clay washed out of sample;

FLUORESCENCE: Short Wave: LF in H2O; **Long Wave:** VLF in H2O.

Plant: Diatoms:

Coscinodiscus synbolophora # **R**

Animal: Foraminifera:

Bolivina barbarana **X**
Brizalina girardensis **X**
Bulimina montereyana # **R**
Buliminella curta **X**
Buliminella elegantissima **C**
Buliminella subfusiformis **R**
Globobulimina cf ovata **X**
Virgulina delmonteensis # **R**
Virgulina ticensis # **R**
Gyroidina soldanii rotundimargo # **X**
Nonion goudkoffi **FE**
Nonionella davanaensis **R**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5750-5780' Late Miocene, early Mohnian (High Resistivity Monterey) Marine

0160-23 **40% Claystone**, medium light to light grayish brown, friable to
Full Sample diffriable, siliceous;

40% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;

10% Mudstone, medium light brown, mottled, friable, siliceous, calcareous, very low hydrochloric acid reaction;

10% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;

1% Mica, Biotite;

No Clay washed out of sample;

FLUORESCENCE: Short Wave: TF in H2O; **Long Wave:** TF in H2O.

Plant: Diatoms:

Coscinodiscus synbolophora # **R**

Animal: Foraminifera:

Ammobaculites sp **X**
Buliminella curta **X**
Buliminella elegantissima **R**
Cibicides spp **X**
Haplophragmoides sp **R**
Nonion medio –costatum* **X**
Nonion sp indeterminate **X**
Nonion sp fragments **R**
Rotaliid sp **X**
Virgulina delmonteensis # **X**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5780-5810' **Late Miocene, early Mohnian (High Resistivity Monterey) Marine**
160-24
Full Sample

79% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
10% Mudstone, medium light brown, mottled, friable, siliceous, calcareous, very low hydrochloric acid reaction;
5% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
5% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
1% Mica, Biotite;
No Clay washed out of sample;

FLUORESCENCE: Short Wave: TF in H2O; **Long Wave:** TF in H2O.

Plant: Diatoms:
Coscinodiscus synbolophora # **R**

Animal: Foraminifera:

Bolivina sp **X**	Trochammina **sp X**
Bolivina sp fragment **X**	Virgulina delmonteensis **# R**
Rotalia garveyensis **X**	Virgulina ticencsis **# X**

5810-5840' **50% Mudstone,** medium light brown, mottled, friable, siliceous, calcareous, very low hydrochloric acid reaction;
0160-25
Full Sample **20% Claystone**, medium light to light grayish brown, friable to diffriable, siliceous;
20% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
10% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
3% Mica, Biotite;
No Clay washed out of sample;
NO FLUORESCENCE.

Animal: Foraminifera:
Buliminella elegantissima **X**
Buliminella sp fragment **X**
Haplophragmoides sp **X**
Rotalia sp **X**
Rotaliid sp **X**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5840-5870' Late Miocene, early Mohnian (High Resistivity Monterey) Marine

0160-26 **55% Mudstone,** medium light brown, mottled, friable, siliceous, calcareous,
Full Sample very low hydrochloric acid reaction;
20% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
15% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
10% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
No Clay washed out of sample;

FLUORESCENCE: Short Wave: TF in H2O; **Long Wave:** VLF in H2O.

Plant: Lignite **R**

Animal: Radiolaria:
Prunopyle titan # **R**

Foraminifera:

Buliminella curta **X**	Gyroidina sp indeterminate # **X**
Buliminella elegantissima **R**	Nonionella davanaensis **X**
Buliminella subfusiformis **X**	Virgulina delmonteensis # **R**

5870-5900' **44% Mudstone,** medium light brown, mottled, friable, siliceous, calcareous,
0160-27 very low hydrochloric acid reaction;
Full Sample **20% Claystone**, medium light to light grayish brown, friable to diffriable, siliceous;
20% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
10% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
5% Shale, medium light to light gray, fissile, friable to diffriable, siliceous;
1% Mica, Biotite;
No Clay washed out of sample;
NO FLUORESCENCE.

Plant: Diatoms:
Coscinodiscus sp. # **X**

Animal: Radiolaria sp # **R**

Foraminifera:
Nonion goudkoffi **X**
Nonion sp indeterminate **X**
Rotalia garveyensis **X**

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	**SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT**
5900-5930'	**Late Miocene, early Mohnian (High Resistivity Monterey) Marine**
0160-28	**60% Mudstone,** medium light brown, mottled, friable, siliceous,
Full Sample	calcareous, very low hydrochloric acid reaction;
	15% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
	10% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
	10% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
	5% Shale, medium light to light gray, fissile, friable to diffriable, siliceous;
	No Clay washed out of sample;
	NO FLUORESCENCE.
	Animal: Radiolaria spp # **R**
	Foraminifera:
	Buliminella elegantissima **X**
	Buliminella subfusiformis **R**
	Nonion goudkoffi **R**
	Nonionella davanaensis **R**
	Virgulina delmonteensis # **X**
	Virgulina ticensis # **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

5930-5960' Late Miocene, early Mohnian (High Resistivity Monterey) Marine

160-29 **49% Mudstone,** medium light brown, mottled, friable, siliceous
Full Sample calcareous, very low hydrochloric acid reaction;
20% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
15% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
10% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
5% Shale, medium light to light gray, fissile, friable to diffriable, siliceous;
1% Mica, Biotite;
No Clay washed out of sample;

FLUORESCENCE: Short Wave: TF in H2O; **Long Wave**: NF.

Plant: Diatoms:
Coscinodiscus spp.# **R**

Animal: Radiolaria spp.
Prunopyle titan # X

Foraminifera:
Brizalina benedictensis **X**
Buliminella brevior **X**
Buliminella elegantissima **F**
Buliminella subfusiformis **X**
Nonion sp indeterminate **R**
Sigmoilina spp **# X**
Virgulina ticensis **# X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT
5960-5990'	**Late Miocene, early Mohnian (High Resistivity Monterey) Marine**
0160-30	**69% Mudstone,** medium light brown, mottled, friable, siliceous, calcareous,
Full Sample	very low hydrochloric acid reaction;
	10% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;
	10% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
	5% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
	5% Shale, medium light to light gray, fissile, friable to diffriable, siliceous;
	1% Mica, Biotite;
	No Clay washed out of sample;
	NO FLUORESCENCE.
	Plant: Lignite **R**
	Animal: Radiolaria
	Spongurus sp. **# X**
5990-6020'	**45% Claystone**, medium light to light grayish brown, friable to diffriable,
0160-31	siliceous;
Full Sample	**40% Mudstone,** medium light brown, mottled, friable, siliceous, calcareous, very low hydrochloric acid reaction;
	10% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
	5% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
	No Clay washed out of sample;
	FLUORESCENCE: Short Wave: BTF in H2O; **Long Wave**: NF.
	Plant: Algae:
	Tytthodiscus sp. # **X**
	Animal Radiolaria:
	: Prunopyle titan # **X**
	Spongodiscus sp.# **X**
	Foraminifera:
	Bolivina sp. Fragments **X**
	Brizalina benedictensis **X**
	Sponge spicule, tetra # **X**
	SPORBO **R**

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R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT
6020-6050'	**Late Miocene, early Mohnian (High Resistivity Monterey) Marine**
160-32	**52% Claystone**, medium light to light grayish brown, friable to
Full Sample	diffriable, siliceous;
	40% Mudstone, medium light brown, mottled, friable, siliceous, calcareous, very low hydrochloric acid reaction;
	5% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
	3% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
	No Clay washed out of sample;
	NO FLUORESCENCE.
	Plant: Diatoms:
	Coscinodiscus symbolophora # **X**
	Animal: Radiolaria spp. **# X**
	Spongodiscus sp #. **X**
	Foraminifera:
	Brizalina benedictensis **X**
	Buliminella elegantissima **R**
	Buliminella subfusifirmis **R**
6050-6080'	**45% Claystone**, medium light to light grayish brown, friable to
0160-33	diffriable, siliceous;
Full Sample	**45% Mudstone,** medium light brown, mottled, friable, siliceous, calcareous, very low hydrochloric acid reaction;
	10% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
	No Clay washed out of sample;
	FLUORESCENCE: Short Wave: TF in H2O; **Long Wave**: TF in H20.
	No fossils encountered

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. **SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT**

6080-6110' **Late Miocene, early Mohnian (High Resistivity Monterey) Marine**

0160-34 **50% Claystone**, medium light to light grayish brown, friable to
Full Sample diffriable, siliceous;
Last Sample **40% Mudstone,** medium light brown, mottled, friable, siliceous,
Examined calcareous, very low hydrochloric acid reaction;
5% Limestone, medium light to light tan, crème, brown streaks, lenticular inclusions, hard,. siliceous, calcareous, very low hydrochloric acid reaction;
5% Shale, medium to medium light brown, fissile, friable to diffriable, siliceous;
No Clay washed out of sample;
FLUORESCENCE: Short Wave: GF in H2O; **Long Wave**: SF in H20.

Animal: Foraminifera:
Haplophragmoides spp. **R**
Echinoid spine fragnment **X**

MARKS AND ASSOCIATES

5964 FIJI STREET, CYPRESS, CALIFORNIA 90630
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E MAIL: MAGeosci@AOL.com

STRATIGRAPHIC REPORT

DATE	: 8 April 2004	ACC. NO.	: 0159
WORKED BY	: E. Marks	AREA	: Sta. Maria
CLIENT	: F. Getz	LOC.	: Barham Rch. Fd.
OPERATOR	: OTEC	COUNTY	: Sta. Barbara
WELL	: No. 1 Boyne	STATE	: California
ELEVATION	: 968' GL, 992' KB	T.D.	: 8297' (-7264' s.s.)
SECTION	: 11 – T7N/R32W SBBM		

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
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SAMPLE #	SPECIES, ABUNDANCE, AGE, FORMATION	ENVIRONMENT
6750-6780'	**Age Late Miocene, E. Delmontian. (Low Resistivity Monterey)**	**Marine**
0159-1	**83% Shale**, medium light brown, fissile, friable, calcareous, medium Hydrochloric Acid reaction;	**Middle Neritic**
Full sample		
First Sample examined	**5% Shale,** light gray, light grayish brown, fissile, friable, calcareous, low Hydrochloric Acid reaction;	
	3% Sand, white, quartzose, medium grained, angular to subangular, loose, clear;	
	3% Mica, biotite, muscovite;	
	3% Siderite;	
	3% Slickensides;	
	Plants: Wood fragments, bn, tan # **R**	
	Animals: Foraminifera:	
	Bolivina sp. **X**	
	Buliminella subfusiformis # **R**	
	Haplophragmoides sp # **R**	
	Rotaliid sp. flat **R**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	**SPECIES, ABUNDANCE, AGE,FORMATION**	**ENVIRONMENT**
6780-6810'	**Age Late Miocene, E. Delmontian. (Low Resistivity Monterey)**	**Marine**
0159-2	**81% Shale**, medium light brown, fissile, friable, siliceous,	**Middle Neritic**
Full sample	calcareous, very low Hydrochloric Acid reaction;	
	10% Shale, light gray, fissile, friable, calcareous, medium to high Hydrochloric Acid reaction**;**	
	3% Limestone, light gray, diffriable to hard, calcareous, high Hydrochloric Acid reaction**;**	
	3% Mica, biotite. Muscovite;	
	3% Slickensides;	
	Plants: Diatoms **R**	
	Wood fragments, bn, tan # **R**	
	Animals: Foraminifera:	
	Haplophragmoides sp **#R**	
	Marginulina sp. **X**	
	Rotaliid sp. flat **R**	
	Radiolaria:	
	Prunopyle titan # * **X**	
	Radiolaria spp. # **R**	
	Spongodiscus sp. # **X**	
	Fish Bone Fragments **X**	
6810-6840'	**75% Shale**, medium light brown, fissile, friable to diffriable,	
159-3	siliceous, calcareous, very low Hydrochloric Acid reaction;	
Full sample	**10% Shale,** light gray, fissile, friable, calcareous, low to medium Hydrochloric Acid reaction**;**	
	3% Limestone, light gray, diffriable to hard, calcareous, medium Hydrochloric Acid reaction**;**	
	3% Sand, white, quartzose, fine to medium grained, angular to subangular, loose, milky to clear;	
	3% Mica, biotite;	
	3% Siderite;	
	3% Slickensides;	
	Animals: Foraminifera:	
	Valvulineria sp. # **R**.	
	Haplophragmoides sp #**X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
6840-6870'	**Age Late Miocene E. Delmont. (Sisquoc)**	**Marine**
159-4	**38% Shale**, medium light brown, fissile, friable, siliceous,	
5/8 sample	No Hydrochloric Acid reaction;	
	13% Shale, light gray, light grayish brown, fissile, friable, calcareous, medium Hydrochloric Acid reaction**;**	
	13% Clay, medium brown, soft, friable, siliceous, No Hydrochloric Acid reaction;	
	3% Limestone, light gray, friable to diffriable, calcareous, medium Hydrochloric Acid reaction**;**	
	3% Siderite;	
	10% Slickensides;	
	38% Clay washed out of sample.	
	Animals: Foraminifera:	
	Rotaliid sp. flat **R**	
6870-6900'	**73% Shale**, medium light to light brown, fissile, friable, siliceous,	
159-5	calcareous, low Hydrochloric Acid reaction;	
7/8 sample	**10% Shale,** light gray, light grayish brown, fissile, friable, calcareous, low Hydrochloric Acid reaction;	
	5% Slickensides;	
	12% Clay washed out of sample.	
	Animals: Foraminifera:	
	Bolivina sp. fragment # **X**	
	Virgulina sp. # **X**	

MARKS AND ASSOCIATES
STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
6900-6930'	**Age Late Miocene E. Delmont. (Sisquoc)**	**Marine**
159-6	**70% Shale**, medium light brown, fissile, friable, siliceous;	
7/8 sample	No Hydrochloric Acid reaction;	
	10% Shale, light gray, fissile, friable, calcareous,	
	medium Hydrochloric Acid reaction;	
	3% Sand, white, quartzose, fine to coarse grained, angular	
	to subangular, loose, milky to clear;	
	5% Slickensides.	
	12% Clay washed out of sample.	
	Animals: Foraminifera:	
	Haplophragmoides sp. # **R**	
	Sigmoilina 6930 # **X.**	
6930-6960'	**88% Shale,** medium brown, fissile, friable to diffriable, 5% soft,	
159-7	siliceous, No Hydrochloric Acid reaction;	
full sample	**5% Shale,** light gray, fissile, friable, slightly calcareous, very	
	low Hydrochloric Acid reaction;	
	5% Siderite;	
	2% Clay washed out of sample.	
	Animals: Foraminifera:	
	Bolivina sp. fragment # **X.**	
	Haplophragmoides sp #**X**	
	Molluscan shell fragments **R**	
6960-6990'	**80% Shale,** medium brown, fissile, friable to diffriable, 5% soft,	
159-8	siliceous, No Hydrochloric Acid reaction**;**	
full sample	**5% Shale,** light gray, fissile, friable, slightly calcareous, very	
	low Hydrochloric Acid reaction;	
	3% Sand, white, quartzose, medium to very coarse grained,	
	angular to subrounded, loose, milky to clear;	
	5% Siderite;	
	3% Oil Fluorescence (Gold color);	
	3% Slickensides;	
	1% Clay washed out of sample.	
	Animals: Molluscan shell fragments **R**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
6990-7020'	**Age Late Miocene E. Delmont. (Sisquoc)**	**Marine**
159-9 full sample	**84% Shale,** medium brown, fissile, friable to diffriable, 5% soft, siliceous, No Hydrochloric Acid reaction**;**	
	3% Sand, white, quartzose, medium to gritty grained, angular to subangular, loose, milky to clear;	
	2% Shale, light gray, fissile, friable to diffriable, siliceous, No Hydrochloric Acid reaction;	
	5% Siderite;	
	5% Oil Fluorescence (Gold color);	
	1% Clay washed out of sample.	
	Animal: Shark Tooth Fragment **X**	
7020-7050'	**90% Shale,** medium brown, fissile, friable to diffriable	
159-10 full sample	siliceous, No Hydrochloric Acid reaction**;**	
	2% Shale, light gray, fissile, friable to diffriable, siliceous, No Hydrochloric Acid reaction**;**	
	2% Limestone, gray, white, calcareous, low Hydrochloric Acid reaction;	
.	**5% Siderite;**	
	1% Clay washed out of sample.	
	Animals: Foraminifera:	
	Haplophragmoides sp. #**X**	
	Porifera**:** Sponge Spicules Straight **R**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7050-7080'	**Age Late Miocene, l. Mohnian, (Monterey Fm)**	**Open Marine**
159-11 full sample	**90% Shale,** medium brown, fissile, friable to diffriable, siliceous, No Hydrochloric Acid reaction**;** **2% Shale,** light gray, fissile, diffriable, slightly calcareous, very low Hydrochloric Acid reaction; **2% Sandstone,** white, quartzose, siliceous cementation, medium to coarse grained, angular to subangular, loose to diffriable, No Hydrochloric Acid reaction, medium to clear; **5% Siderite;** **1% Clay washed out of sample.** Animal: Fish Bone Fragments **R** Fish jaw? **X** Foraminifera: Sphaeroidinellopsis subdehiscens # * **X** Molluscan shell fragments **R**	
7080-7110'	**92% Shale,** medium to medium light brown, fissile, friable to diffriable	
159-12 full sample	siliceous, 10% calcareous, low Hydrochloric Acid reaction**;** **3% Limestone,** white, calcareous, low Hydrochloric Acid reaction; friable to diffriable**;** **5% Siderite;** **3% Slickensides;** **No Clay washed out of sample.** Animals: Gastropods: Ficus cf modesta **X.**	
7110-7140'	**89% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	
159-36 full sample	**10% Shale,** medium to light gray, fissile, diffriable to hard, siliceous; **3% Sandstone,** white, light gray, quartzose, silty to medium grained, angular to subrounded, friable to hard, milky to clear, siliceous cement; **3% Siderite,** low HCl reaction; **No Fluorescence;** **No Clay washed out of sample.** Animal: Foraminifera Bolivina sp fragment **#X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7140-7170'	**Age Late Miocene, late Mohnian, (Monterey Fm)**	**Open Marine**
159-37	**76% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	
Full sample	**10% Shale,** medium to light gray, fissile, diffriable to hard, siliceous, calcareous, very low to low Hydrochloric Acid reaction;	
	3% Claystone, light gray, friable to diffriable, calcareous, low to medium Hydrochloric Acid reaction;	
	5% Siderite, low HCl reaction;	
	1% Pyrite;	
	5% Wood Fragments;	
	No Fluorescence;	
	No Clay washed out of sample.	
	Plant: Wood Fragments, bn, tan # **C**	
7170-7200'	**Age Late Miocene, late Mohnian, (Monterey Fm)**	**Marine**
159-38	**88% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	**Middle Neritic**
Full sample	**5% Shale,** medium to light gray, fissile, diffriable to hard, siliceous;	
	3% Claystone, light gray, friable to diffriable, calcareous, very low to low Hydrochloric Acid reaction;	
	1% Sandstone, white, light gray, quartzose, silty to coarse grained, angular to subrounded, diffriable to hard, milky to clear, siliceous cement;	
	3% Siderite, , low HCl reaction;	
	1% Fluorescence, (1 fragment) mineral? No odor, stream, color;	
	No Clay washed out of sample.	
	Animal: Foraminifera	
	Bolivina sp? fragment # **X**	
7200-7230'	**84% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	
159-39	**5% Shale,** medium to light gray, fissile, friable to diffriable, siliceous;	
Full sample	**3% Claystone,** light gray, soft, friable, calcareous, low Hydrochloric Acid reaction;	
	3% Siltstone, light gray, quartzose, silty grained, diffriable to hard, milky to clear;	
	5% Siderite, , low HCl reaction;	
	1% Fluorescence, (3 fragments) mineral? No odor, stream, color;	
	No Clay washed out of sample.	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7230-7260'	**Age Late Miocene, late Mohnian, (Monterey Fm)**	**Probably Marine**
159-40	**87% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	
Full sample	**5% Shale,** medium light to light gray, fissile, diffriable to hard, siliceous;	
	3% Claystone, light gray, soft, friable, siliceous;	
	5% Siderite, low HCl reaction;	
	No Fluorescence;	
	No Clay washed out of sample.	
	Animal: Bone Fragments **X**	
7260-7290'	**Age Late Miocene, late Mohnian, (MontereyFm)**	**Marine**
159-41	**89% Shale,**medium to light brown, fissile, diffriable to hard, siliceous;	**Outer Neritic to Bathyal**
Full sample	**5% Limestone, l**ight tan, light gray, friable to diffriable, calcareous, Low Hydrochloric Acid reaction;	
	3% Shale, light gray, fissile, diffriable to hard, siliceous;	
	3% Siderite, low HCl reaction;	
	No Fluorescence;	
	No Clay washed out of sample.	
	Animals: Foraminifera	
	Bulimina montereyana **# X**	
	Haplophragmoides sp **# R**	
	Nonion spp. indeterminate **X**	
	Rotalia garveyensis *** X**	
	Rotalia sp **X**	
	Gastropod shell fragments **X**	

MARKS AND ASSOCIATES
STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7290-7320'	**Age Late Miocene, late Mohnian, (Monterey Fm)**	**Marine**
159-42	**86% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	
Full sample	**5% Shale,** light gray, fissile, diffriable to hard, siliceous;	
	3% Claystone, medium light gray, soft, friable to diffriable, siliceous, calcareous, very low Hydrochloric Acid reaction;	
	3% Limestone, very light gray, diffriable to hard, calcareous, low to medium Hydrochloric Acid reaction;	
	3% Siderite, low HCl reaction;	
	1% Fluorescence, (1 fragment - mineral?) No odor, stream, color;	
	No Clay washed out of sample.	
	Animals: Foraminifera	
	Rotalia garveyensis **X**	
7320-7350'	**TOP Age Late Miocene, early Mohnian (MontereyFm)**	**Marine**
0159-43	**83% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	**Outer**
Full sample	**10% Shale,** medium light to light gray, fissile, diffriable to hard, siliceous;	**Neritic**
	3% Claystone, medium light brownish gray, friable to diffriable, siliceous, calcareous, very low Hydrochloric Acid reaction;	
	1% Limestone, light creme, diffriable to hard, calcareous, low Hydrochloric Acid reaction;	
	3% Siderite, low HCl reaction;	
	No Fluorescence;	
	No Clay washed out of sample.	
	Animals: Foraminifera	
	Bolivina Sp **X**	
	Virgulina ticensis #***X**	
7350-7380'	**91% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	
159-44	**3% Shale,** medium light to light gray, fissile, diffriable to hard, siliceous;	
Full sample	**3% Claystone,** medium light grayish brown, friable to diffriable, siliceous, calcareous, very low Hydrochloric Acid reaction;	
	3% Siderite, low HCl reaction;	
	No Fluorescence;	
	No Clay washed out of sample.	
	Animals: Foraminifera	
	Haplophragmoides sp #**X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT
7380-7410'	**Age Late Miocene, early Mohnian, (Monterey Fm) Marine**
159-45 Full sample	**77% Shale,** medium to light brown, fissile, diffriable to hard, siliceous; **5% Shale,** medium light to light gray, fissile, diffriable to hard, siliceous; **5% Limestone**, very light gray, diffriable to hard, calcareous, low to medium Hydrochloric Acid reaction; **3% Claystone,** medium light grayish brown, friable to diffriable, siliceous; **5% Wood fibers;** **5% Siderite,** low HCl reaction; **No Fluorescence;** **No Clay washed out of sample.** Animals: Foraminifera Haplophragmoides sp #**X**
7410-7440'	**83% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;
159-46 Full sample	**3% Shale,** medium light to light gray, fissile, diffriable to hard, siliceous;
	3% Claystone, medium light grayish brown, friable to diffriable, siliceous; **1% Limestone**, very light tan, diffriable to hard, calcareous, low Hydrochloric Acid reaction; **5% Wood fibers;** **5% Siderite,** low HCl reaction; **No Fluorescence;** **No Clay washed out of sample.** Animals: Foraminifera Haplophragmoides sp #**X**

MARKS AND ASSOCIATES

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT
7440-7470'	**Age Late Miocene, early Mohnian, (Monterey Fm) Marine**
159-47	**81% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;
Full sample	**5% Shale,** medium light to light gray, fissile, diffriable to hard, siliceous;
	3% Claystone, light gray, soft, friable, calcareous, very low to low Hydrochloric Acid reaction;
	5% Wood fibers;
	5% Siderite, low HCl reaction;
	1% Pyrite;
	No Fluorescence;
	No Clay washed out of sample.
	Animals: Foraminifera:
	Haplophragmoides sp #**X**
	Radiolaria spp. #**X**
	Porifera: Sponge Spicule Straight **R**
	Molluscan Shell Frags **X**
7470-7500'	**76% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;
159-48	**10% Shale,** medium light to light gray, fissile, friable to hard, siliceous;
Full sample	**5% Claystone,** medium light grayish brown, friable to diffriable, calcareous, low Hydrochloric Acid reaction;
	3% Sandstone, white, very light creme, quartzose, silty to very coarse grained, angular to subrounded, diffriable to hard, milky to clear, siliceous cement;
	5% Siderite, low HCl reaction;
	No Fluorescence;
	No Clay washed out of sample.

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT
7500-7530'	**Age Late Miocene, early Mohnian, (Monterey Fm) Open Marine**
159-49	**73% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;
7/8 sample	**5% Shale,** medium light to light gray, fissile, friable to hard, siliceous, calcareous, very low Hydreochloric Acid reaction;
	3% Claystone, medium light to light brown, friable to diffriable, calcareous, low Hydrochloric Acid reaction;
	2% Limestone, medium light to light creme, diffriable to hard, calcareous, low to medium Hydrochloric Acid reaction;
	1% Siltstone, medium light gray**,** quartzose, silty grained, angular, diffriable to hard, milky to clear, siliceous cement;
	3% Siderite, low HCl reaction;
	No Fluorescence;
	12% Clay washed out of sample.
	Animals: Foraminifera
	Haplophragmoides sp #**C**
	Nonionella cf extensa **X**
	Bolivina sp**?** # **X**
	Radiolaria: Prunopyle titan # *** X**
	Porifera: Sponge Spicule Straight **C**
7530-7560'	**93% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;
150-50	**3% Shale,** medium light to light gray, fissile, diffriable to hard, siliceous;
Full sample	**1% Limestone,** light creme, diffriable to hard, calcareous, low to medium Hydrochloric Acid reaction;
	3% Siderite, low HCl reaction;
	No Fluorescence;
	3% Siderite, low HCl reaction;
	No Fluorescence;
	No Clay washed out of sample.
	Animals: Foraminifera
	Haplophragmoides sp #**X**
	Radiolaria: Prunopyle titan ***#X**
	Porifera: Sponge Spicule Straight **C**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7560-7590'	**Age Late Miocene, early Mohnian, (Monterey Fm)**	**Marine**
0159-51	**85% Shale,** medium to light brown, fissile, diffriable to hard,	**Middle**
Full sample	siliceous;	**Neritic**
	3% Shale, medium light to light gray, fissile, diffriable to hard, siliceous;	
	3% Claystone, medium light to light grayish brown, friable, calcareous, low Hydrochloric Acid reaction;	
	3% Limestone, medium light to light tan, diffriable to hard, calcareous, low to medium Hydrochloric Acid reaction;	
	5% Siderite, low HCl reaction;	
	1% Pyrite;	
	No Fluorescence;	
	No Clay washed out of sample.	
	Animals: Foraminifera	
	Bolivina sp**. # R**	
	Rotalia garveyensis ***X**	
7590-7620'	**75% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;	
159-52	**5% Claystone,** medium light to light gray, friable to diffriable,	
Full sample	calcareous, low Hydrochloric Acid reaction;	
	3% Shale, medium light to light gray, fissile, diffriable to hard, siliceous;	
	3% Limestone, medium light to light tan, diffriable to hard, calcareous, low to medium Hydrochloric Acid reaction;	
	3% Siltstone, medium light to light gray, quartzose, silty to very fine grained, angular to subangular, friable to diffriable, milky to clear, siliceous cement;	
	5% Siderite, low HCl reaction;	**1% Pyrite;**
	No Fluorescence;	**5% Wood Fragments**
	No Clay washed out of sample.	
	Plant:: Plant Roots pyritized **R**	
	Animals: Radiolaria**?** Spp # **X**	
	Porifera: Sponge Spicule Straight **R**	
	Sponge Spicule tetra # **R**	

MARKS AND ASSOCIATES

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7620-7650'	**Age Late Miocene, early Mohnian, (Monterey Fm)**	**Marine**
0159-53	**`90% Shale,** medium to light brown, fissile, diffriable to hard,	
Full sample	siliceous;	
	3% Shale, medium to medium light gray, fissile, diffriable to hard, calcareous, low Hydrochloric Acid reaction;	
	3% Claystone, medium light to light grayish brown, friable to diffriable, calcareous, low Hydrochloric Acid reaction;	
	3% Siderite, low HCl reaction; **1% Wood fragments;**	
	No Fluorescence; **No Clay washed out of sample**	
	Plant: Plant Roots pyritized # **X**	
	Animal: Radiolaria**?** Spp #**X**	
	Porifera: Sponge Spicule Straight **C**	
7650-7680'	**79% Shale,** medium to light brown, fissile, diffriable to hard, **Non-**	
0159-54	siliceous; **Marine**	
Full sample	**5% Claystone,** medium light to light grayish brown, friable **Influence** to diffriable, siliceous;	
	3% Limestone, white, friable to diffriable, calcareous, very low to low Hydrochloric Acid reaction;	
	3% Siltstone, light to very light gray, quartzose, silty to very fine grained, angular to subangular, diffriable to hard, milky to clear, siliceous cement	
	3% Limestone, white, friable to diffriable, calcareous, very low to low Hydrochloric Acid reaction;	
	3% Siltstone, light to very light gray, quartzose, silty to very fine grained, angular to subangular, diffriable to hard, milky to clear, siliceous cement	
	5% Siderite, low HCl reaction; **1% Pyrite;**	
	No Fluorescence; **2% Calcite,** light orange	
	No Clay washed out of sample.	
	Plant: Plant Roots pyritized #**R**	
	Wood Fragments, bn, tan #**C**	
	Wood Fragments, lignitized #**R**	
	Diatoms #**X**	
	Animal: Porifera: Sponge Spicule Straight **R**	

MARKS AND ASSOCIATES

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7680-7710'	**Age Late Miocene, early Mohnian, (Monterey Fm)**	**Marine**
0159-55	**83% Shale,** medium to light brown, fissile, diffriable to hard, siliceous,	**Non-**
Full sample	calcareous, low Hydrochloric Acid reaction;	**Marine**
	3% Shale, medium to medium light gray, fissile, friable to hard, siliceous;	**Influence**
	3% Claystone, medium light to light grayish brown, friable to diffriable, siliceous, calcareous, low Hydrochloric Acid reaction;	
	3% Limestone, white, light creme, light brown, diffriable to hard, calcareous, low to medium Hydrochloric Acid reaction;	
	3% Siderite, low HCl reaction; **2% Calcite,** light orange	
	No Fluorescence; **5% Wood Fragments**	
	No Clay washed out of sample.	
	Plant: Plant Fragments #**X**	
	Seed Pod #**X**	
	Animals: Foraminifera	
	Buliminella spp Fragment #**X**	
	Haplophragmoides sp #**X**	
	Radiolaria**?** Spp #**X**	
	Porifera: Sponge Spicule Straight **R**	
7710-7740'	**80% Shale,** medium to light brown, fissile, diffriable to hard, siliceous, calcareous, very low Hydrochloric Acid reaction;	
159-56		
Full sample	**3% Shale,** light gray, fissile, diffriable to hard, siliceous;	
	3% Claystone, medium light to light grayish brown, friable to diffriable, siliceous;	
	3% Limestone, white, light tan, diffriable to hard, calcareous, very low to medium Hydrochloric Acid reaction;	
	3% Siderite, low HCl reaction; **2% Calcite,** light orange;	
	No Fluorescence; **3% Wood Fragments;**	
	No Clay washed out of sample. **3% slickensides.**	
	Plant: Coal # **X**	
	Wood Fragments, lignitized # **C**	
	Animal: Foraminifera	
	Buliminella subfusiformis #**X**	
	Haplophragmoides sp #**R**	
	Rotalia garveyensis ***X**	
	Radiolaria**?** Spp #**X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

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SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7740-7770'	**Age Late Miocene, early Mohnian, (Monterey Fm)**	**Marine**
0159-57	**68% Shale,** medium light to light brown, fissile, diffriable to hard, **Non-**	
7/8 sample	siliceous,	**Marine**
	5% Shale, medium light to light gray, fissile, diffriable to hard, **Influence**	
	siliceous,	
	3% Claystone, medium light to light gray, medium light grayish brown, friable to diffriable, calcareous, very low Hydrochloric Acid reaction;	
	2% Limestone, light tan, friable to hard, calcareous, low Hydrochloric Acid reaction;	
	3% Siderite, low HCl reaction;	**2% Calcite,** light orange;
	No Fluorescence;	**5% limestone backed**
	12% Clay washed out of sample.	**By slickensides.**
	Plant: Wood Fragments, bn, tan #**C**	
	Wood Fragments, lignitized # **R**	
	Animal: Foraminifera	
	Haplophragmoides sp #**R**	
	Radiolaria**?** Spp # **X**	
	Porifera: Sponge Spicule Straight **R**	
	Fish Bone Fragments **R**	
7770-7800'	**88% Shale,** medium to light brown, fissile, diffriable to hard, siliceous,	
159-58	**3% Claystone,** medium light to light grayish brown, friable	
Full sample	to diffriable, calcareous, very low Hydrochloric Acid reaction, 30% with slickensides;	
	3% Siderite, low HCl reaction;	**5% Slickensides;**
	1% Pyrite	**No Fluorescence;**
	No Clay washed out of sample.	
	Animal: Radiolaria**?** Spp # **X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
7800-7830'	**Age Late Miocene, early Mohnian, (Monterey Fm)**	**Marine,**
159-59	**86% Shale,** medium to light brown, fissile, diffriable to hard,	**Non-Marine**
Full sample	siliceous,	**Influence**
	10% Claystone, medium light to light grayish brown, friable to diffriable, calcareous, very low Hydrochloric Acid reaction, 30% claystone with slickensides;	
	5% Siderite, low HCl reaction;	**5% Slickensides;**
	No Clay washed out of sample.	**No Fluorescence;**
	Plant: Coal **# X**	
	Plant Fragments**?** **# X**	
	Seed Pod **# X**	
	Animal: Radiolaria**?** Spp #**X**	
	Porifera Sponge Spicule Straight **R**	
	Fish Bone fragments**?** **R**	
7830-7860'	**82% Shale,** medium to light brown, fissile, diffriable to hard, siliceous,	
159-60	**10% Claystone,** medium light to light grayish brown, friable	
Full sample	to diffriable, siliceous, calcareous, very low Hydrochloric Acid reaction, 5% claystone with slickensides;	
	5% Siderite, low HCl reaction;	**3% Slickensides;**
	No Clay washed out of sample.	**No Fluorescence;**
	Plant: Coal **# R**	
	Animal: Foraminifera	
	Haplophragmoides sp **#R**	
	Nonionella cf extensa **X**	
	Rotalia garveyensis **# R**	
	Gastropod shell fragments **X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

7860-7890' Age Late Miocene, early Mohnian, (Monterey Fm) Marine

159-617/8 sample **71% Shale,** medium to light brown, fissile, diffriable to hard, siliceous; **Outer Neritic**

10% Claystone, medium light to light grayish brown, friable to diffriable, siliceous, calcareous, low Hydrochloric Acid reaction, 10% claystone with slickensides;

2% Limestone, light tan, diffriable to hard, calcareous, low Hydrochloric Acid reaction;

5% Siderite, low HCl reaction; **5% Slickensides;**

12% Clay washed out of sample. **No Fluorescence.**

Plant: Coal **# R**

Animal: Foraminifera
Rotalia garveyensis ***X**
Virgulina grandis ***#X**
Molluscan shell fragments **X**

7890-7920' 159-62 full sample **63% Shale,** medium to light brown, fissile, diffriable to hard, siliceous, calcareous, low Hydrochloric Acid reaction;

10% Claystone, medium light to light grayish brown, friable to diffriable, calcareous, low Hydrochloric Acid reaction, 5% claystone with slickensides;

5% Limestone, medium light to light brown, diffriable to hard, calcareous, low Hydrochloric Acid reaction;

5% Siderite, low HCl reaction; **5% Slickensides;**

No Clay washed out of sample. **No Fluorescence.**

Plant: Coal **# X**

Animal: Foraminifera
Rotalia garveyensis ***X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

7920-7950' Age Late Miocene, early Mohnian, (Monterey Fm) Marine
159-63 **72% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;
7/8 sample **5% Claystone,** medium light to light grayish brown, friable to diffriable, calcareous, low Hydrochloric Acid reaction;
2% Limestone, medium light to light brown, diffriable to hard, calcareous, low Hydrochloric Acid reaction;
3% Siderite, low HCl reaction; **1% Slickensides;**
2% Calcite, light orange; **3% Wood fragments;**
12% Clay washed out of sample. **No Fluorescence**
Animal: Foraminifera
Rotalia garveyensis ***R**

7950-7980' 69% Shale, medium to light brown, fissile, diffriable to hard, siliceous;
159-64 **10% Claystone,** medium light to light grayish brown, friable
7/8 sample to diffriable, siliceous, calcareous, very low Hydrochloric Acid reaction;
3% Limestone, light gray, diffriable to hard, calcareous, low Hydrochloric Acid reaction;
3% Siderite, low HCl reaction; **3% Calcite,** light orange;
12% Clay washed out of sample; **No Fluorescence.**
Plant: Coal **# X**
Animal: Foraminifera
Nonion spp indeterminate **X**
Molluscan shell fragments **X**

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #. SPECIES, ABUNDANCE, AGE,FORMATION ENVIRONMENT

7980-8010' Age Late Miocene, early Mohnian, (Monterey Fm) Marine
159-63 **89% Shale,** medium to light brown, fissile, diffriable to hard, siliceous;
Full sample **5% Claystone,** medium light to light grayish brown, friable to hard, siliceous;
3% Limestone, very light gray, diffriable to hard, calcareous, low Hydrochloric Acid reaction;
3% Siderite, low HCl reaction;
No Fluorescence;
No Clay washed out of sample.
Animal: Foraminifera
Rotalia garveyensis ***X**
Molluscan shell fragments **R**

8010-8040' 89% Shale, medium to light brown, fissile, diffriable to hard, siliceous;
159-64 **5% Claystone,** medium light to light brown, friable to diffriable, siliceous;
Full sample **3% Limestone,** very light gray, diffriable to hard, calcareous, low Hydrochloric Acid reaction;
3% Siderite, low HCl reaction;
No Fluorescence;
No Clay washed out of sample.
Plant: Coal # **X**
Animal: Molluscan shell fragments **R**

8040-8070' Sample Missing.

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
8070-8100'	**Age Late Miocene, Mohnian, (Monterey Fm)**	**Open Marine**
0159: 13-15	**88% Shale,** medium to medium light brown, fissile,	**Outer Neritic**
Full sample	diffriable to hard, siliceous, calcareous, low Hydrochloric Acid reaction;	
	5% Mudstone, light brown, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	3% Shale, light gray, fissile, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	2% Siderite;	
	1% Pyrite;	
	1% Slickensides;	
	No Clay washed out of sample.	
	Animals: Foraminifera	
	Bolivina sp fragment **#X**	
	Haplophragmoides sp **#X**	
	Rotalia garveyensis ***X**	
	Valvulineria araucana **# X**	
	Radiolaria : Prunopyle titan (with cortex) #* **X**	
	Porifera: Sponge spicule straight **X**	
8100-8130'	**97%Shale,** medium to medium light brown, fissile, diffriable	
0159: 16-18	to hard, siliceous, calcareous, low Hydrochloric	
Full sample	Acid reaction;	
	2% Shale, light gray, fissile, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	1% Siderite;	
	No Clay washed out of sample.	
	Animals: Foraminifera	
	Nonionella cf extensa **X**	
	Rotalia garveyensis ***X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
8130-8160'	**Age Late Miocene, Mohnian, (Monterey Fm)**	**Marine,**
0159: 19-21	**94% Shale,** medium to medium light brown, fissile,	**Middle Neritic**
Full sample	friable to hard, siliceous, calcareous, low Hydrochloric Acid reaction;	
	3% Shale, light gray, fissile, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	3% Siderite;	
	No Clay washed out of sample.	
	Animal: Foraminifera	
	Rotalia sp **X**	
	Bolivina sp **#X**	
8160 – 8190'	**Age Late Miocene, Mohnian, (Monterey Fm)**	**Marine**
0159: 22-24	**88% Shale,** medium to medium light brown, fissile,	**Outer**
Full sample	friable to hard, siliceous, calcareous, very low Hydrochloric Acid reaction;	**Neritic**
	3% Shale, light gray, fissile, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	3% Limestone, orange, hard, calcareous, low Hydrochloric Acid reaction;	
	1% Mudstone, light brown, soft to friable, calcareous, very low Hydrochloric Acid reaction;	
	5% Siderite;	
	No Clay washed out of sample	
.	Plants: Wood Fragments, bn, tan **# VA**	
	Animal: Foraminifera	
	Rotalia garveyensis ***X**	
	Rotalia spp **X**	
	Uvigerina modeloensis # ***X**	
	Fish teeth **X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
8190-8220'	**Age Late Miocene, Mohnian, (Monterey Fm)**	**Marine**
0159: 25-27	**93% Shale,** medium to medium light brown, fissile,	**Outer**
Full sample	friable to hard, siliceous, calcareous, very low Hydrochloric Acid reaction**;**	**Neritic**
	3% Shale, light gray, fissile, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	2% Mudstone, light brown, soft to friable, siliceous, slightly calcareous, very low Hydrochloric Acid reaction;	
	2% Siderite;	
	No Clay washed out of sample.	
	Plant: Wood fragments bn, tan # **VA**	
	Animal: Foraminifera:	
	Brizalina vaughani # **X**	
	Cibicides sp # **R**	
	Nonionella cf extensa **X**	
	Virgulina grandis *#X	
	Radiolaria:	
	Spongodiscus sp. #**X**	
	Fish Teeth **X**	
	?Mammalian Tooth **X**	
8220-8250'	**90% Shale,** medium to medium light brown, fissile, friable to	
0159: 28-30	hard, siliceous, calcareous, low Hydrochloric	
Full sample	Acid reaction**;**	
	5% Shale, light gray, fissile, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	3% Siderite;	
	1% Pyrite;	
	1% Calcite;	
	No Clay washed out of sample..	
	Plant: Wood fragments bn, tan # **FE**	
	Animals: Foraminifera	
	Rotalia garveyensis ***X**	

MARKS AND ASSOCIATES

STRATIGRAPHIC REPORT, CONT'D

X=Very Rare (1) **C**=Common (9-32) **VA**= Very Abundant (121-2000)
R=Rare (2-4) **A**=Abundant (33-120) **FL**=Flood (>2000)
FE=Few (5-8)
RW = Reworked * = Index Fossil # = Environmental indicator

SAMPLE #.	SPECIES, ABUNDANCE, AGE,FORMATION	ENVIRONMENT
8250-8280'	**Age Late Miocene, Mohnian, (Monterey Fm)**	**Marine**
0159: 31-33	**88% Shale,** medium to medium light brown, fissile, friable	**Outer**
Full sample	to hard, siliceous, calcareous, low	**Neritic**
	Hydrochloric Acid reaction**;**	
	3% Mudstone, light brown, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	2% Shale, light gray, fissile, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	1% Sand, white, quartzose, fine to medium grained, sub-angular to subrounded, loose, milky to clear;	
	5% Siderite; 1% Pyrite;	
	No Clay washed out of sample.	
	Plant: Wood fragments bn, tan # **R**	
	Animal: Foraminifera	
	Bolivina sp **X**	
	Virgulina sp. **X**	
	Fish teeth **X**	
8280-8290'	**Age Late Miocene, Mohnian, (Monterey Fm)**	
8293' Circulated	**Age: Late Miocene, Delmontian, Sisquoc**	
0159: 34-35	**88% Shale,** medium to medium light brown, fissile, friable	
Full sample	to hard, siliceous, calcareous, very low	
Last Sample	Hydrochloric Acid reaction**;**	
	3% Shale, light gray, fissile, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	2% Mudstone, light brown, soft to friable, calcareous, low Hydrochloric Acid reaction;	
	1% Sandstone, white, quartzose, calcareous cement, fine to very coarse grained, angular to subrounded, diffriable to hard, milky to clear;	
	5% Siderite; 1% Pyrite;	
	No Clay washed out of sample.	
	Plants: Wood Fragments bn, tan #**VA**	
	Animals: Radiolaria	
	Spongodiscus sp. #**X**	

APPENDIX B

FIGURES

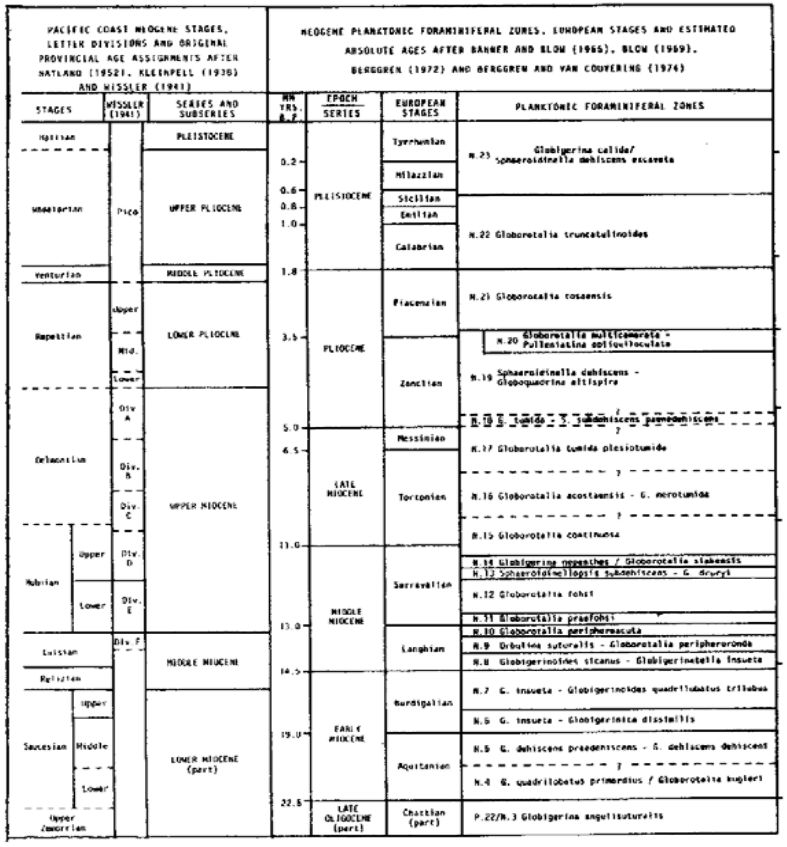

Figure 1. Relationships of Neogene zonation, correlating California Stages, Years Before Present, and Pelagic worldwide zonation (Kleinpell, 1981, p.111)

CORRELATION CHART

UNITS/ MARKERS	CABOT 1 Ferrero-Hopkins	SUN 5 Blair	TRITON 10 Blair	OTEC 1 Boyne
LATE MIOCENE **EARLY DELMONTIAN** **SISQUOC FORMATION**				**6840'** **Early Delmontian** **Sisquoc** **8290'** **Early Delmontian** **Sisquoc**
LATE MIOCENE EARLY DELMONTIAN, LATE MOHNIAN **LOW RESISTIVITY MONTEREY FM.**			5090' late. Mohnian. Low Resistivity Monterey Fm.	6750' E. Delmontian. Low Resistivity 7050' late. Mohnian. Low Resistivity Monterey Fm.
LOW/HIGH RESISTIVITY E-LOG MARKER	**12595'**	**11230'**	**5413'**	**(NO E-LOG)**
LATE MIOCENE EARLY MOHNIAN **HIGH RESISTIVITY MONTEREY FM.**	12880' Pt* 12910' Pt 13000' Pt 13030' Aa 13060' Aa 13080' Gs	12090' early Mohn High Resistivity. Monterey Fm. 12150' e. Mohnian High Res. Monterey 12210' e. Mohnian High Res. Monterey.	5420' early Mohn. High Resistivity. Monterey Fm. 6110' T.D., Still early Mohnian High Resistivity. Monterey Fm.	7320' e. Mohnian High Resistivity Monterey Fm. 8160' Mohnian High Resistivity. Monterey Fm

Figure 2. Correlation chart of Santa Maria Basin wells examined and horizons noted. The important Low/High Resistivity e-log marker ("L/H") appears to be coeval with the Late/Early Mohnian point. Wells are: Cabot No. 1 Ferrero-Hopkins, Sun No. 5 Blair, Triton No. 10 Blair and OTEC No. 1 Boyne, Santa Maria Basin, Santa Barbara County, California.

- Marker abbreviations: **Pt** = *Prunopyle titan;* **Aa** = *Axoprunum angelinum;* **Gs** = *Glyphodiscus stellatum.*

PALEO-ENVIRONMENTALCHART, SANTA MARIA AREA

Depth	Cabot 1 Ferrero-Hopkins				Sun 5 Blair				Triton No. 10 Blair				OTEC No. 1 Boyne			
		Shal	Neritic	Bthyl		Shal	Neritic	Bthyl		Shal	Neritic	Bthyl		Shal	Neritic	Bthyl
	M C	Mar	I M O	U M L	M C	Mar	I M O	U M L	M C	Mar	I M O	U M L	M C	Mar	I M O	U M L
+800																
+700																
+600													6700'			
'+500													6800'			
+400													6900'			
+300									5100'				7000'			
+200									5200'				7100'			
+100									5300'				7200'			
L/H	12595'				11230'				5413'				7320'			
-100	12600'				11300'			?	5500'				7400'			
-200	12700'				11400'			?	5600'				7500'			
-300	12800'				11500'			?	5700'				7600'			
-400	12900'				11600'			?	5800'				7700'			
-500	13000'				11600'			?	5900'				7800'			
-600	13100'				11700'			?	6000'				7900'			
-700	13200'				11800'			?	6100'				8000'			
-800	13300'				11900'			?					8100'			
-900					12000'			?					8200'			
-1000					12100'											
-1100					12200'											
-1200																
-1300																

Fig. 3. Paleo-Environmental Chart, comparing wells CABOT 1 Ferrero-Hopkins, SUN 5 Blair, TRITON 10 Blair and OTEC 1 Boyne water depth curves, Santa Maria Basin, Santa Barbara Co., California. Well column headers: Well name, First Column M= Montane, C = Continental, Shal Mar = Shallow Marine, Neritic, I= Inner, M = Middle, O = Outer; Bthyl = Bathyal, U=Upper, M=Middle, L=Lower.

APPENDIX C

RANGE CHARTS

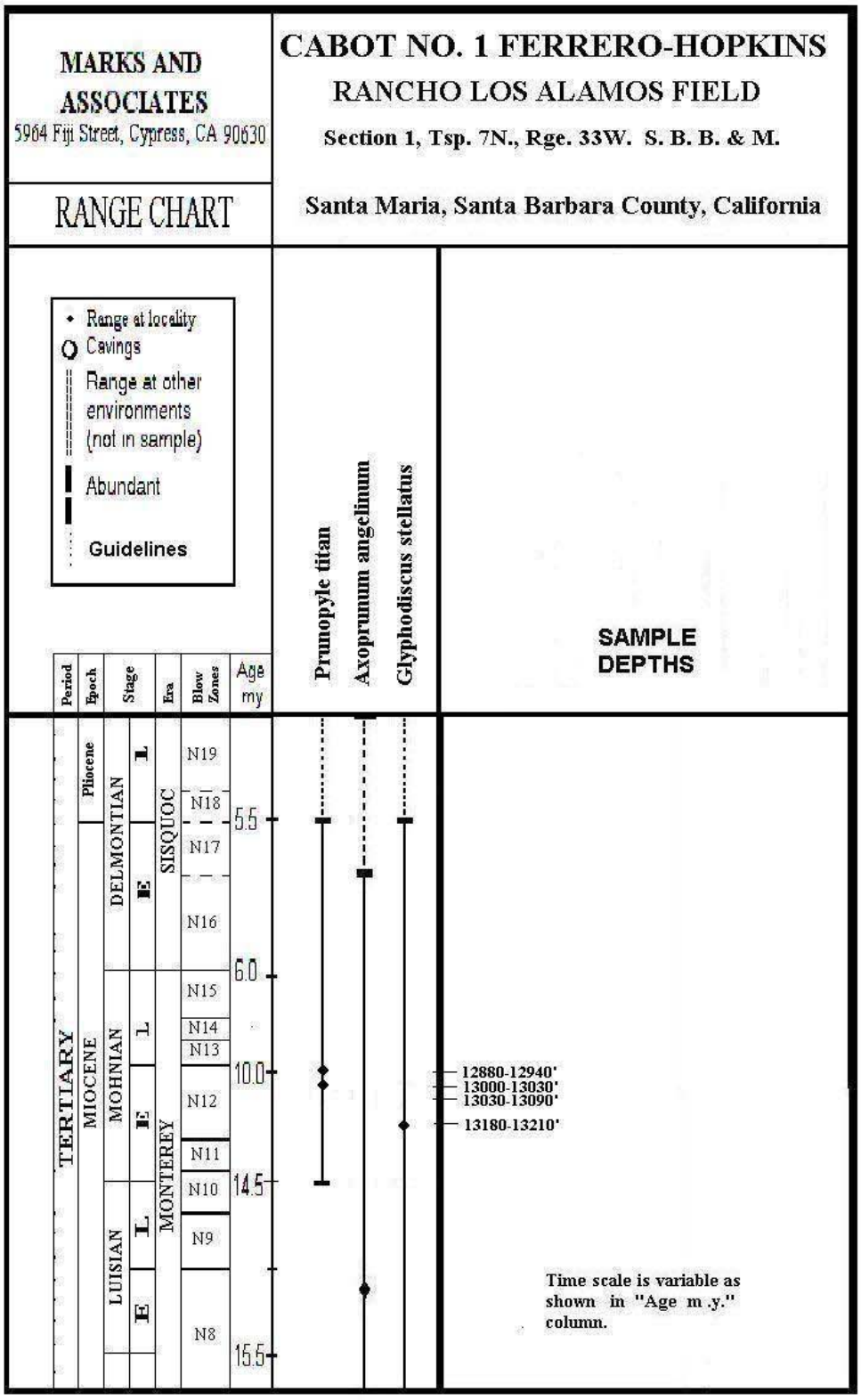

Chart 1. Range chart for index fossils in cuttings from 3918m (12850') to 4032m (13225') in well Cabot No. 1 Ferrero-Hopkins, Rancho Los Alamos Field, Sec 1, Tnsp 7N, Rge 33W, SBB&M, Santa Barbara Co., CA.

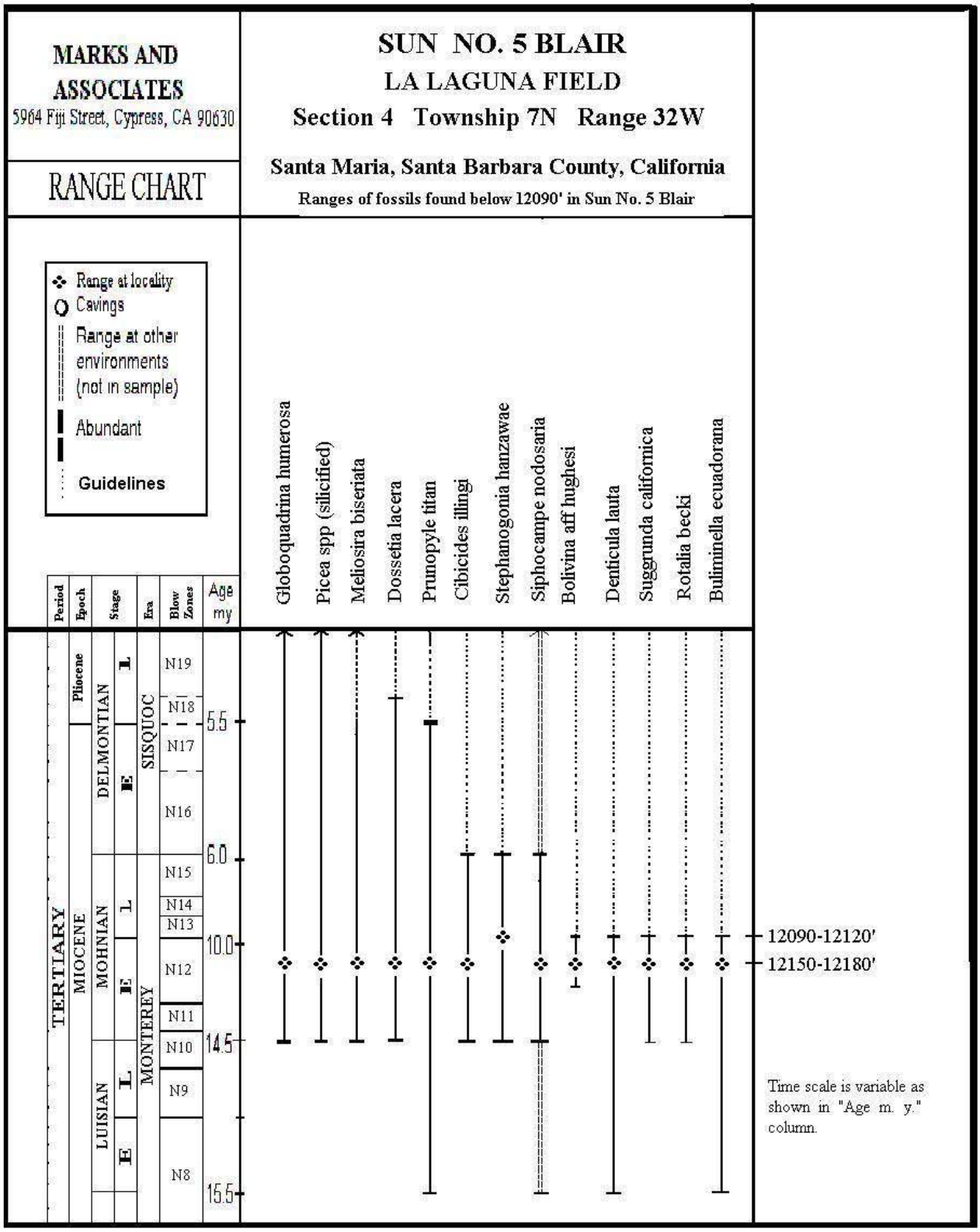

Chart 2. Range chart for index fossils found in cuttings from 3686m (12090') to 3722m (12210') in well Sun No.5 Blair, La Laguna Field, Sec 4, Tsp 9N, Range 32W, SBB&M, Santa Barbara Co., CA.

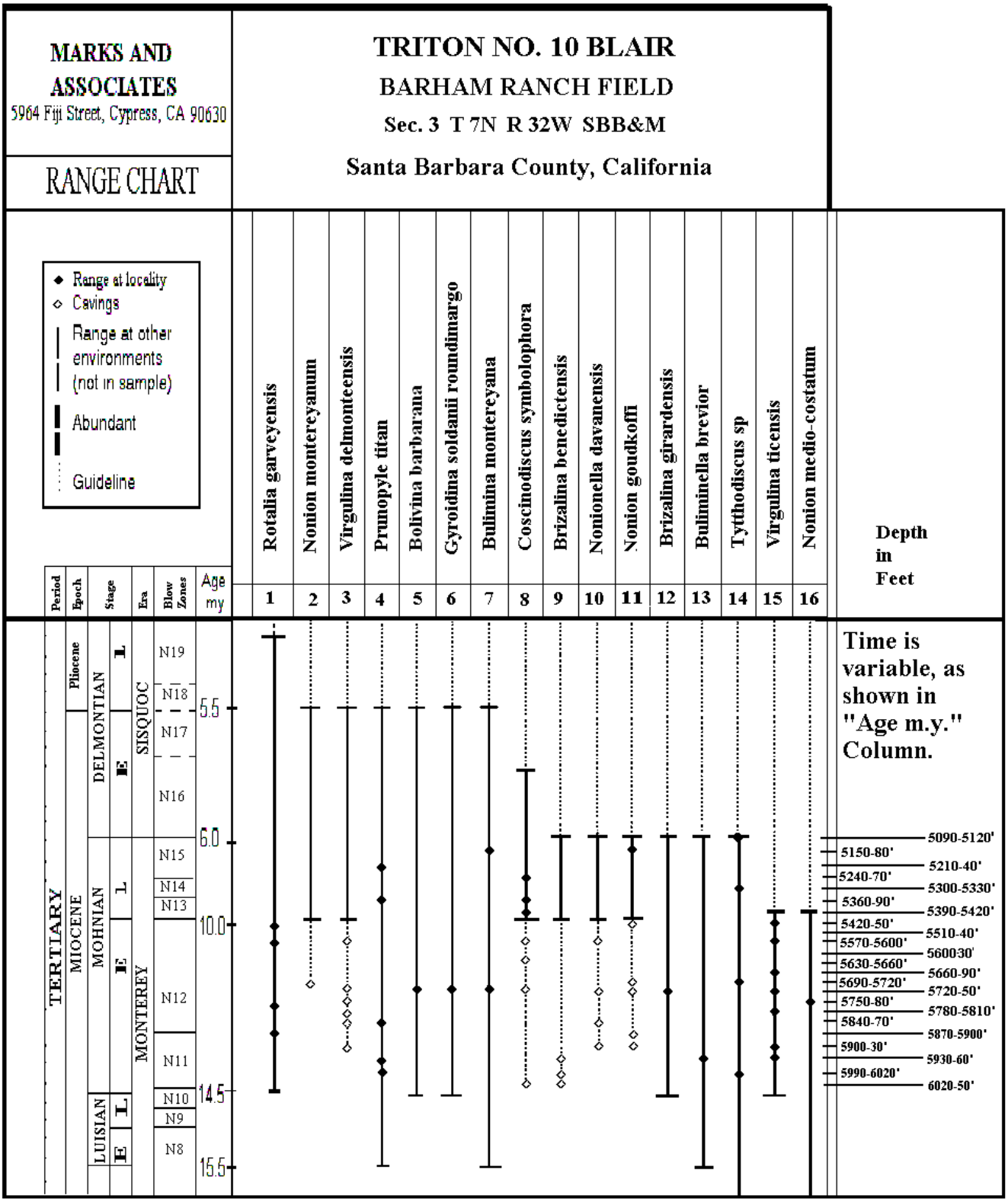

Chart 3. Range chart for index fossils found in cuttings from 1552m (5090') to 1863m (6110') in well Triton 10 Blair, Rancho Los Alamos, Barham Ranch Field, Sec 3, Tsp7N, R 32W, SBB&M, Santa Barbara Co., CA.

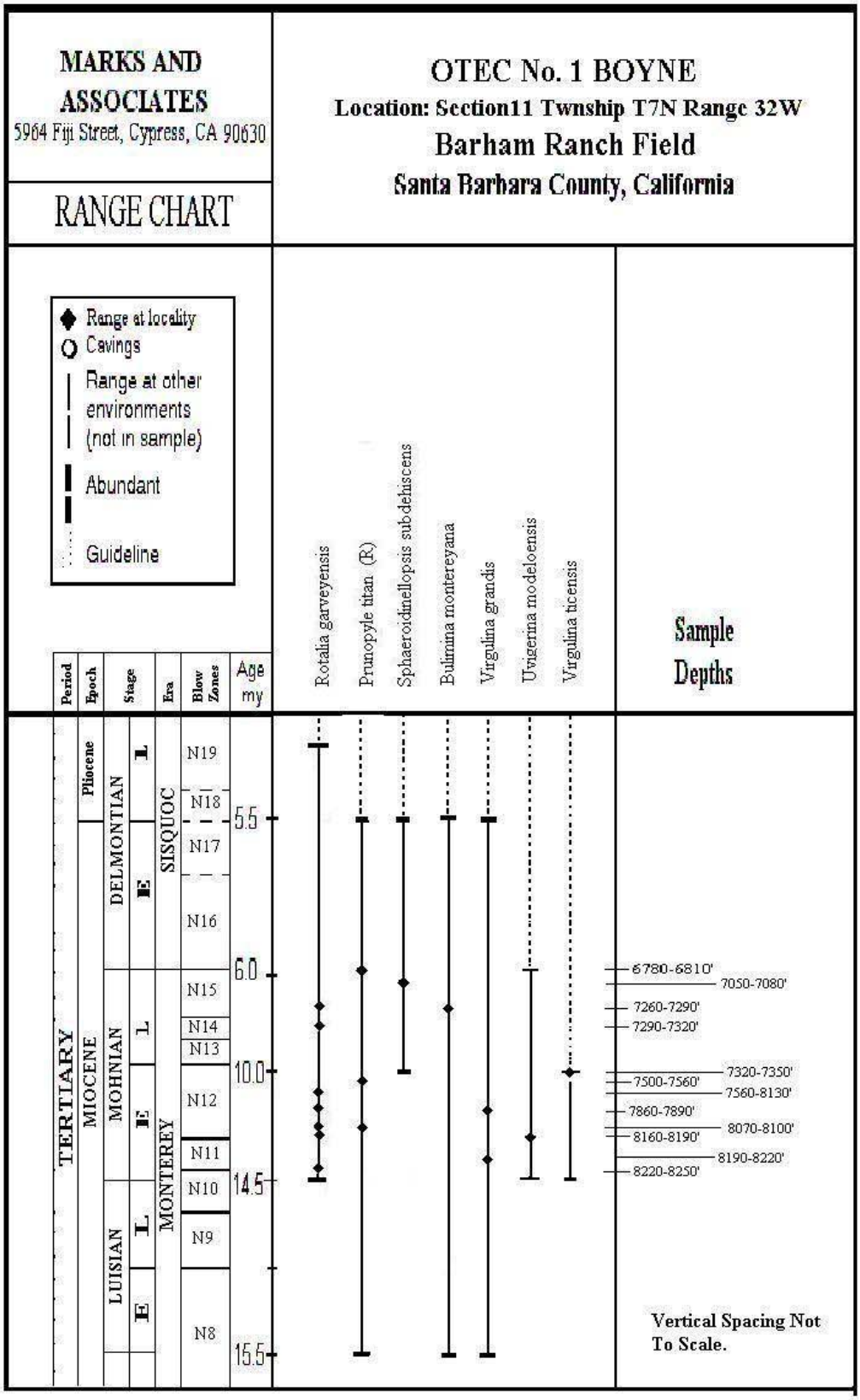

Chart 4. Range chart for index fossils found in cuttings from 2058m (6750') to 2528m (8293') in well Otec No. 1 Boyne, Barham Ranch Field, Sec 11, T7N, R32W, SBB&M, Snata Barbara Co., CA.

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5964 Fiji Street
Cypress, Ca. 90630

Range Chart of Index Fossils, Santa Maria Area Santa Barbara County, California

[A] -- Algal Cyst [D] -- Diatom [F] --Foram [P] --Pollen [R] -- Radiolarian

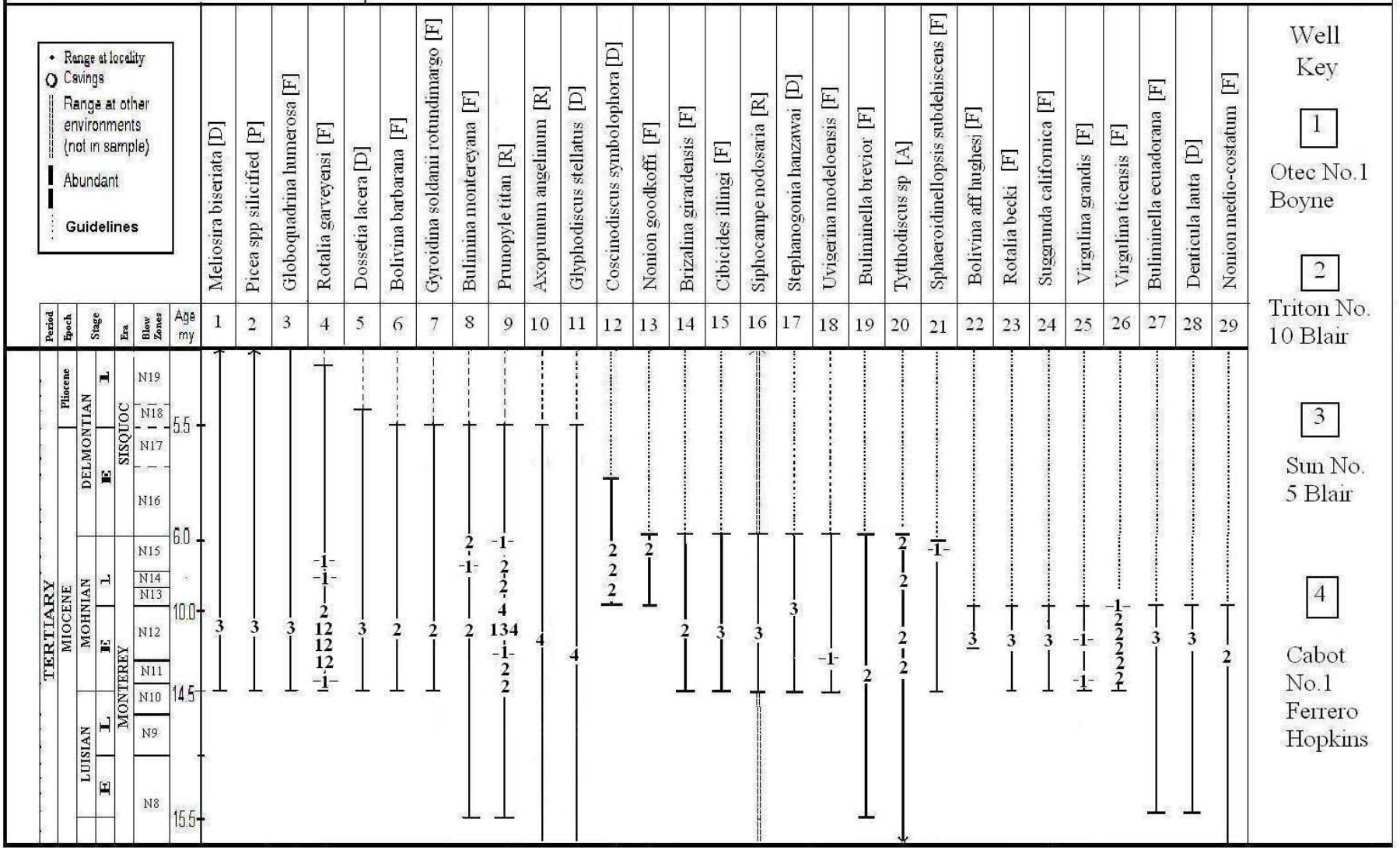

Chart 5. Range chart for index fossild found in cuttings from wells Cabot No.1 Ferrero-Hopkins, Sun No. 5 Blair, Triton No. 10 Blair and Otec No.1 Boyne, Santa Maria Basin, Santa Barbara County, California.

APPENDIX D

LITHOLOGIC REPORT AND CHARTS

LITHOLOGIC REPORT AND CHARTS

PURPOSE

The purpose of the lithologic examination is to determine the percentages of shales and clays as well as the other lithic elements in the samples examined. Argillaceous sediments were predominant in all wells examined. The majority of the sediments were fissile shales,, both brown and gray, mudstones, clays and limestones.

The wells and intervals examined were:

CABOT No. 1 Ferrero Hopkins, Sec. 1, T 7 N./R 33 W., SBB & M.
3917.7 m (12850') to 4032 m (13225'), 13 cuttings samples
SUN No. 5 Blair, Sec. 4, T 7 N. / R 32 W., SBB & M.
3412 m (11190') to 3722.5 m (12210'), 34 cuttings samples
TRITON No. 10 Blair, Sec. e T 7.N/R 32 W., SBB & M.
1552 m (5090') to 1863 m (6110'), 34 cuttings samples
OTEC No. 1 Boyne, Sec. 11, T 7 N./R32 W., SBB & M
2058 m (6750') to 2528 m (8293'), 66 cuttings samples

THE LITHOLOGIC CHART

The chart has been arrayed with a grain size column to the left, a percentage log in the center, accessory minerals present to the right of the percentage log, a column for Hydro-Chloric Acid reaction to its right, and a special column for percentages of ultra-violet light fluorescence on the right side. On the far left are sample depths, and on the far right are the sample numbers. The log is arrayed to a vertical scale of 25.4 mm (1 inch) to 15 m (50'). Most samples represent 15.14m (30') intervals. The bottom of the lithic log for the OTEC No. 1 Boyne, from 2460 m (8070') to 2528 m (8293'), TD, has been examined and displayed at 3.05 m (10 foot) intervals.

GRAIN SIZE

The left side of the chart is marked from the center out, in increasing grain size, from clay and shale at the center, through silt, very fine sand, fine sand, medium sand, coarse, gritty, pebbly and (not seen under a microscope) boulder grain size. This gives us clues as to the energy of deposition of the sediments encountered. Coarser material is usually deposited by higher energy, such as wave or current action; while finer material, such as clays and silts are usually deposited by quieter waters, as below wave base.

THE LITHOLOGIC CHART, cont'd

PERCENTAGE LOG

A percentage log has been constructed from the examination of the samples. The percentage log corresponds to what has been found and reported in the narrative log included in the Stratigraphic Reports, Appendix A, pp.25 to 89, above. This provides a visual picture of what is in the ground. Percentages of rock are estimated by the writer, plotted on special forms, and displayed on the chart. The log runs vertically to the right of the Grain Size chart, in the center of the whole chart. The wider the width of the color depicted, the larger percentage of that rock is displayed.

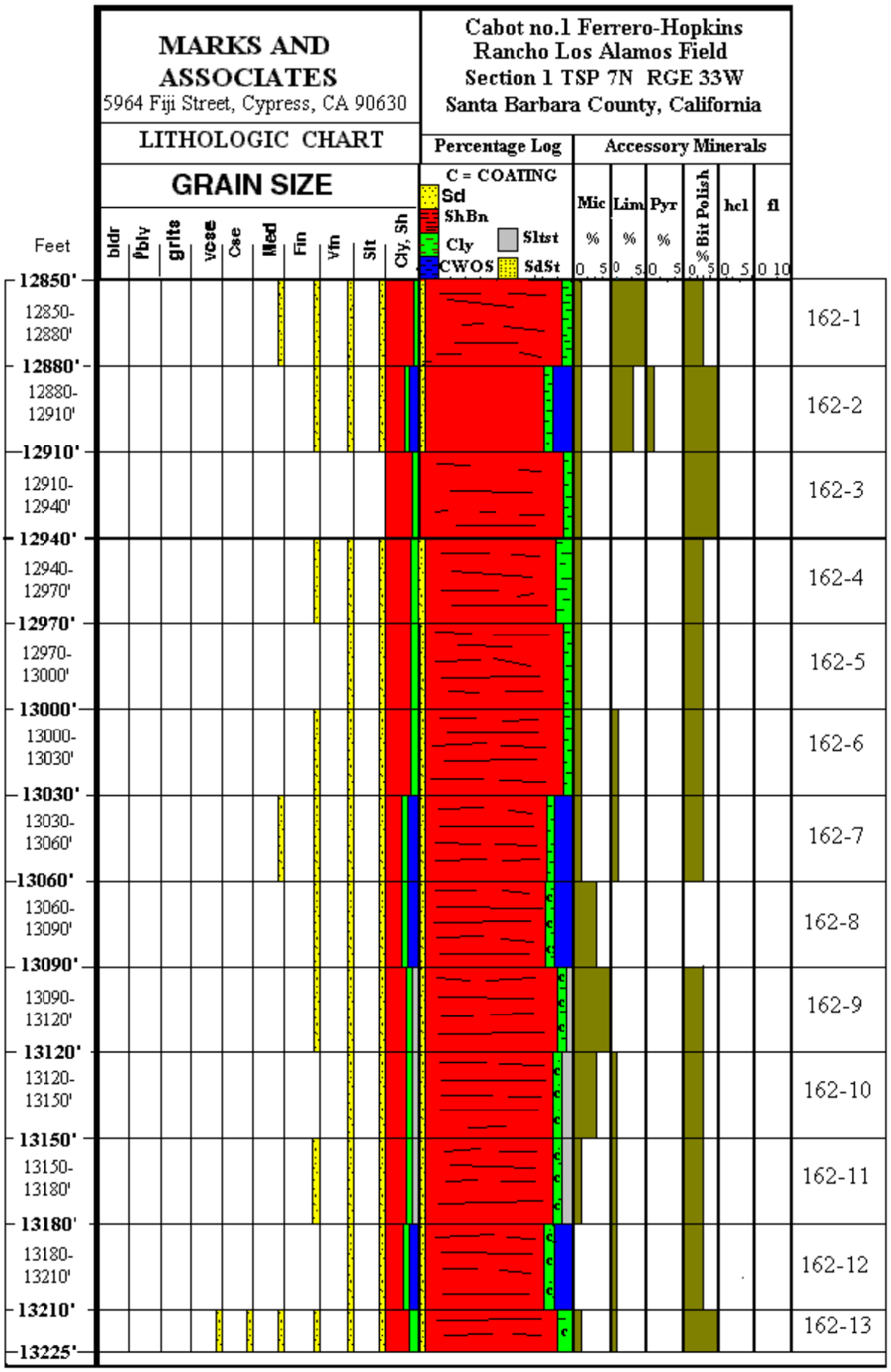

Chart 6. Lithologic chart for well Cabot No. 1 Ferrero-Hopkins, Sec 1, Tnsp 7N, Rge 33W,SBB&M, Santa Barbara Co., CA. for interval 3918m (12850') to 4032m (13225').

MARKS AND ASSOCIATES
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LITHOLOGIC CHART

SUN 5 BLAIR
LA LAGUNA FIELD
Sec 4 T 7 N R 32W SBB&M
Santa Barbara C0., California

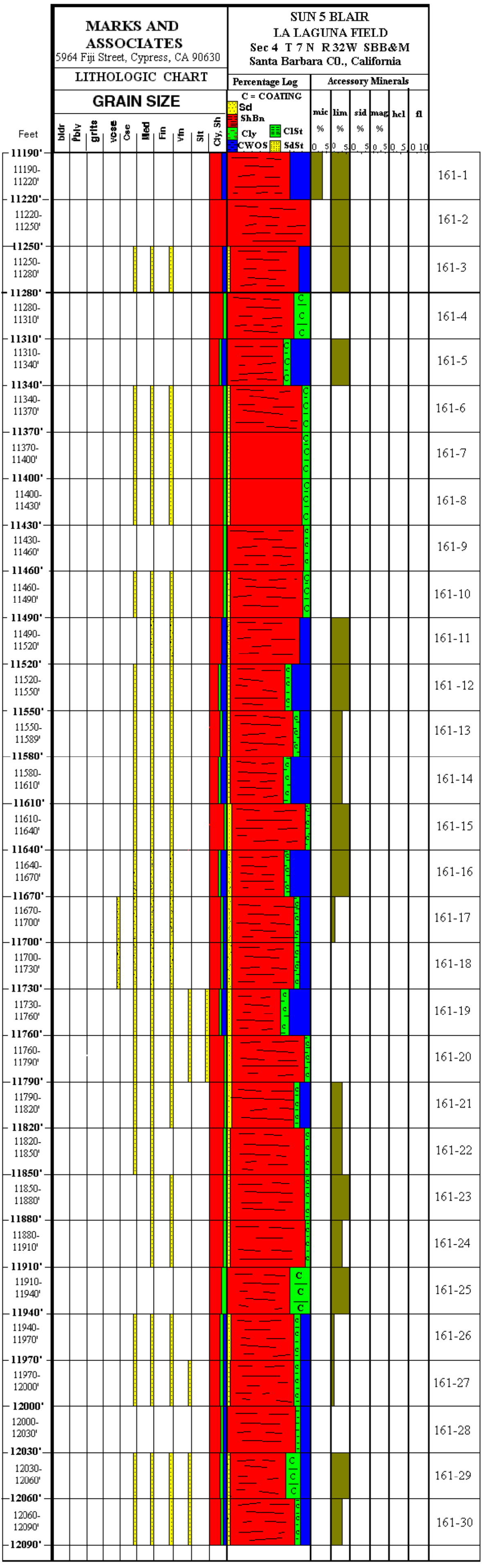


Chart 7. Lithologic chart for well Sun No.5 Blair, Sec 4, TNSP 7N, R32W, SBB&M, Santa Barbara Co., CA. for interval 3412m (11190') to 3686m (12090').

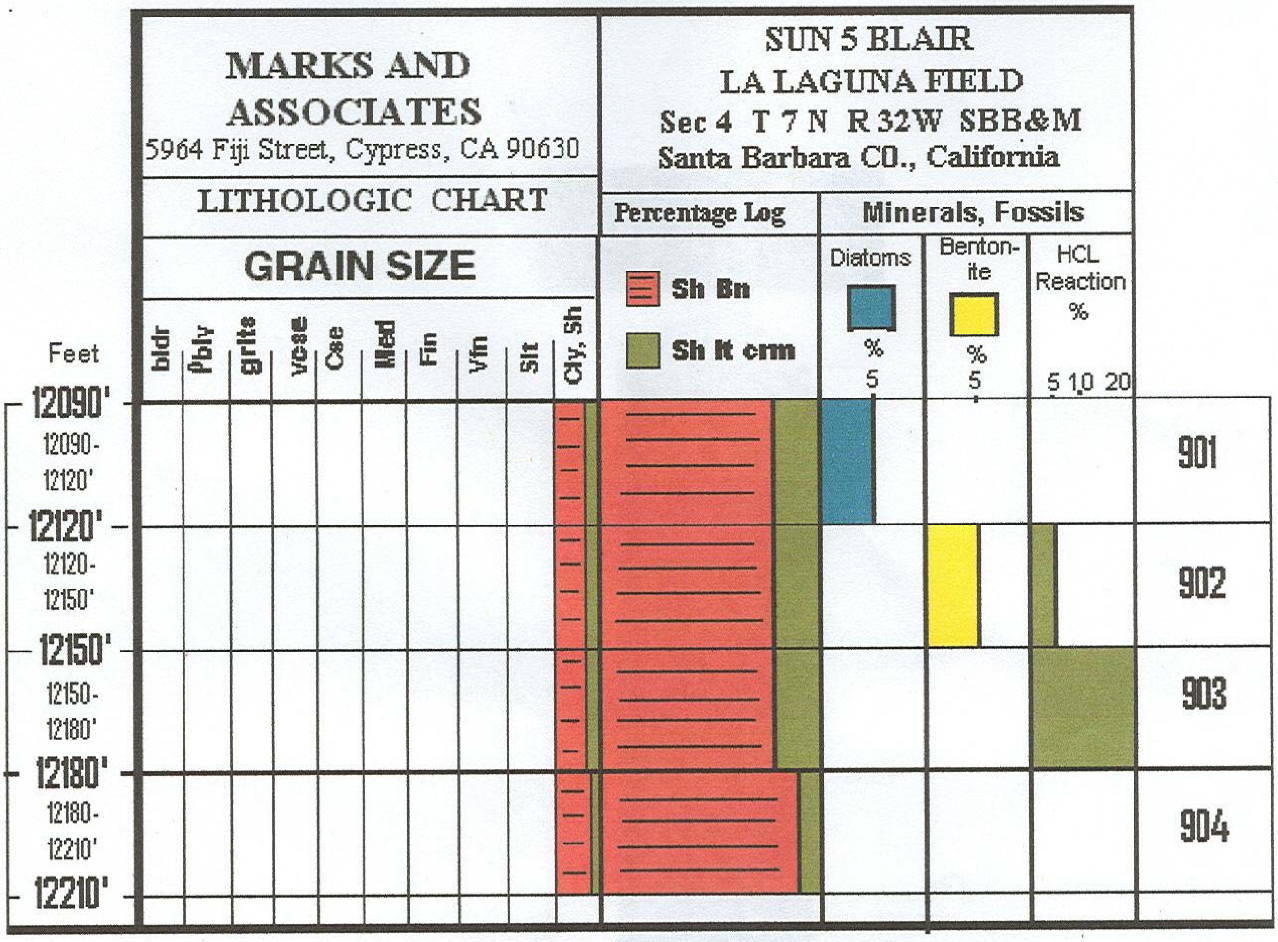


Chart 8. Lithologic chart for well Sun No. 5 Blair Sec 4, Tnsp 7N, Rge 32W, SBB&M. Santa Barbara Co., CA. for interval 3686m (12090') to 3722m (12210').

MARKS AND ASSOCIATES
5964 Fiji Street, Cypress, CA 90630
EDWARD MARKS, ANALYST
GREGORY EDWARD KOCH, C.A.D.

LITHOLOGIC CHART

TRITON NO. 10 BLAIR
BARHAM RANCH FIELD
Sec 3 T 7N R 32W SBB&M
Santa Barbara County, California

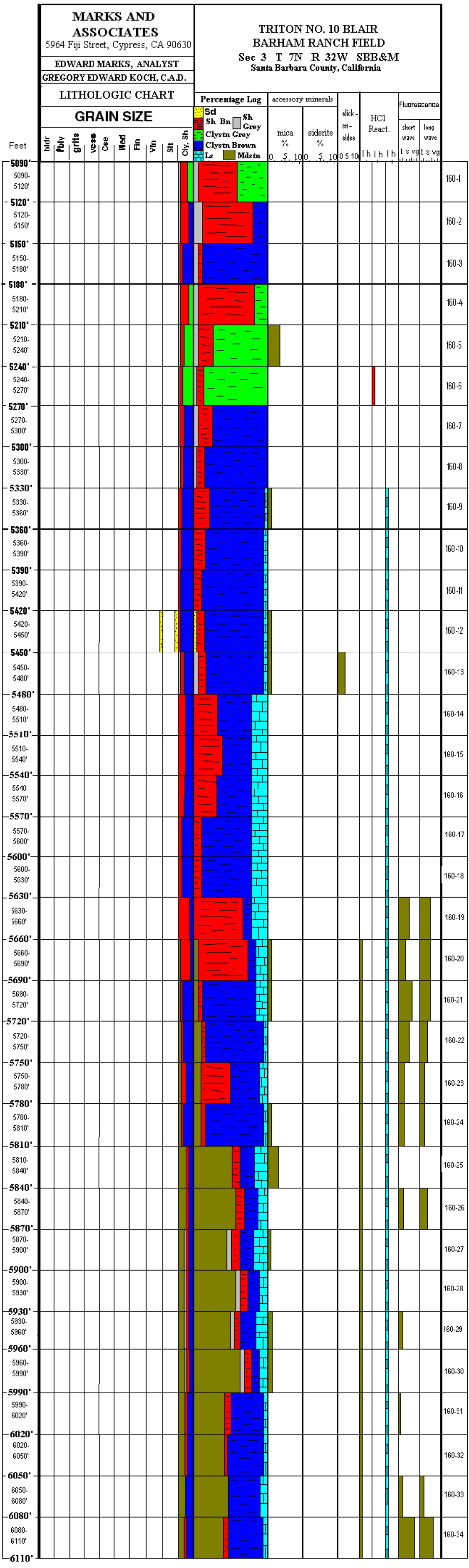


Chart 9. Lithologic chart for well Triton No. 10 Blair, Sec. 3, Tsp. 7N/Rge. 32 W, SBB&M, Santa Barbara Co., CA, for interval 1552m (5090') to 1863 m (6110'), TD.

MARKS AND ASSOCIATES
5964 Fiji Street, Cypress, CA 90630

LITHOLOGIC CHART

GRAIN SIZE

OTEC 1 BOYNE
BARHAM RANCH FIELD
Sec. 11 - T7N/R32W - SBBM
Santa Barbara Co., California

APPENDIX E

FOSSIL DISTRIBUTION CHARTS

FOSSIL DISTRIBUTION CHARTS

PURPOSE

The purpose of the Fossil Distribution Charts is to help identify ages and paleo-environments based on the age ranges of the fauna and flora and their habitats and life zones in which the fossils found in the samples occupied. This is a tool to increase production, reduce operating costs and risks, and reduce environmental concerns.

Plates 1 to 5 are fossil distribution charts listing the samples in rows and the associated faunal and floral species in columns. This is produced by a computer program called "Checklist II,' devised by Mr. F. J. Phillips, Denver, CO. The data is exported to a Microsoft Excel file and placed in PDF to transmit it to the Department of Energy for illustration. By using this program we can find highest occurrences of fossils in a well, very important for identifying oil or gas formations.

DISPLAY

Columns list the species noted in the well. Samples are arrayed in rows, from the shallowest sample in the well example to the deepest sample examined. The abundance of the occurrence of each species is listed where it was found in the row of the sample examined. A key to the abundances is shown on the chart.

Colors indicate the habitats and environments of deposition of each species, and are depicted in an Environmental Legend. Warm colors are usually used for non-marine and shallowest marine habitats, and cool colors for deeper marine habitats. Data for environmental determinations were derived from many sources including Barker [2], Ingle [15] and Loeblich [18], listed in references, p. 21, above.

Plates enclosed are as follows:

Plate 1: CABOT No. 1 Ferrero Hopkins, Sec. 1, T 7 N./R 33 W., SBB & M.
3917.7 m (12850') to 4032 m (13225')
Plate 2: SUN No. 5 Blair, Sec. 4, T 7 N. / R 32 W., SBB & M.
3412 m (11190') to 3686 m (12090')
Plate 3: SUN No. 5 Blair, Sec. 4, T 7 N. / R 32 W., SBB & M.
3686 m (12090') to 3722.5 m (12210')
Plate 4: TRITON No. 10 Blair, Sec. e T 7.N/R 32 W., SBB & M.
1552 m (5090') to 1863 m (6110')
Plate 5: OTEC No. 1 Boyne, Sec. 11, T 7 N./R32 W., SBB & M
2058 m (6750') to 2528 m (8293')

RESULTS

Age. Four of the five fossil distribution charts proved useful in age dating the sediments in the wells.

TRITON No. 10 Blair contained 63 microfossils, 16 of which were index fossils, listed on Chart 4, Range Chart for TRITON 10 Blair, p. 98. Highest occurrences of the important index fossils are readily apparent on the Fossil Distribution Chart.

The well **OTEC No. 1 Boyne** yielded 43 taxa, of which 7 were index fossils, listed on the Range Chart, Chart 5, p. 99. By the spacing of fossils on the chart we can see highest occurrences, such as that of *Virgulina ticensis* indicating the top of the early Mohnian High Resistivity Monterey Fm. pay zone, as well as repeated assemblages that help to mark faulted sediments, such as *Haplophragmoides sp.*reappearing at 2213 – 2222 m (7260-7290').

CABOT No. 1 Ferrero-Hopkins yielded two index Radiolaria, *Prunopyle titan* and *Axoprunum angelinum,* both dying out at the end of the late Miocene. An index Diatom, *Glyphodiscus stellatus* also ranged to the top of the late Miocene. This proved that we can assume that the interval examined in Cabot 1 Ferrero-Hopkins was also in the early Mohnian, High Resistivity Monterey Formation.

The well, **SUN No. 5 Blair,** yielded markers only in the section examined in 1993. This section, just below 3636 m (12090') proved indicative of the early Mohnian, see p.10, 11. Important markers, such as *Bolivina aff hughesi, Denticula lauta, Suggrunda californica, Rotalia becki* and *Buliminella ecuadorana* all died out at the end of the late Miocene, early Mohnian, and all were present in the sample 3704 m – 3713 m (12150-12180'). Other fossils in this sample were noted as first appearing in the early Mohnian (see p.15, above). This is good evidence that this well interval was in the High Resistivity Monterey Fm., the productive zone.

CABOT NO. 1 FERRERO-HOPKINS FOSSIL DISTRIBUTION CHART Plate 1.

MARKS AND ASSOCIATES
5964 Fiji Street
Cypress, California 90630

DATE: March 11, 2005
ANALYSTS: E. Marks, I. Marks, J. Urban
CAD: G. E. Koch
CLIENT: Frank Getz
PROJECT NUMBER: 0162
OPERATOR: Cabot
WELL: No. 1 Ferrero-Hopkins
SECTION: Sec 1 Tsp 7N Rge 33W SBB&M
AREA: Santa Maria
LOCATION: Rancho Los Alamos Field
COUNTY: Santa Barbara, California
TOTAL DEPTH: 13225'
ELEVATION: KB 934'

Environmental Legend

- G0 General
- S0 Montane General
- A2 Aquatic Moist
- P1 Eupelagic
- B2 Benthic Paralic
- B4 Benthic Inner Neritic

ABUNDANCE LEGEND

X Very Ra	(+1)	C Common	(9-32)
R Rare	(2-4)	A Abundant	(33-120)
F Few	(5-8)	VA Very Abun	(121-2000)
		FL Flood	(>2000)

	1	2	3	4	5	6	7	8	9	10	11	12
	Wood Fragments, bn,tn	Prunopyle titan	Molluscan Shell Fragments	Radiolaria sp	Coal	Coscinodiscus spp (D)	Haplophragmoides sp	Uvigerinella sp	Axoprunum angelinum	Algal cyst?	Glyphodiscus stellatus	Spongodiscus sp (R)
	S0WoodBT	P1PrunTi	S0Moll02	P1Rada01	G0Coal01	P1Coss01	B2Hapd01	B4Uvge01	P1AxomAm	A2AlgaC?	P1GlysSs	P1Spons0
12850-12880 ft	R											
12880-12910 ft		X										
12910-12940 ft		X	R	R								
12940-12970 ft				R								
12970-13000 ft				X								
13000-13030 ft		R		R	X	X	R	X				
13030-13060 ft	R					X			X			
13060-13090 ft							R		X	X		
13090-13120 ft				R								
13120-13150 ft				R								
13150-13180 ft				R								
13180-13210 ft				R							X	
13210-13225ft				R		X						X

Sun No. 5 Blair Fossil Distribution Chart

Plate 2.

CLIENT: FRANK GETZ
PROJECT: SUN 5 BLAIR
AREA: SANTA MARIA
LOCATION: LA LAGUNA FIELD
SECTION: 4
TOWNSHIP: 7N
RANGE: 32W
COUNTY: SANTA BARBARA
ANALYST: E. Marks, D. Berry
DATE: December 13,2004

Environmental Key

- G0 General
- S0 Montane General
- A0 Aquatic General
- B2 Benthic Paralic
- B3 Benthic Shallow Marine

Abundance Legend

X Very Rare (+1)
R Rare (2-4)
F Few (5-8)
C Common (9-32)
A Abundant (33-120)
VA Very Abundant (121-2000)
FL Flood (>2000)

	1	2	3	4	5	6	7	8	9
	A0FshBA0	A0FiSc02	B2Foram?	S0Moll02	G0PFraBn	B3Spro01	G0Plnt02	S0WoodBT	B2Gast02
	Fish Bone Fragments	Fish Scale Frags	Foraminifera?	Molluscan Shell Fragments	Plant fiber brown	SPORBO	Plant Fragments	Wood Fragments, bn,tn	Gastropod shell fragments
11190-11220 ft	R	R	R	R	X	R			
11220-11250 ft	X		R	R		X	X		
11250-11280 ft	X		F	F		X		X	
11280-11310 ft	X	X	C	F	X	X		R	
11310-11340 ft	X		A	F				X	
11340-11370 ft	X		A	F		X			
11370-11400 ft			A	X					
11400-11430 ft	X		A	X		X		X	
11430-11460 ft	X		C					X	C
11460-11490 ft	X		C					X	C
11490-11520 ft			C						A
11520-11550 ft			C						A
11550-11580 ft			C					X	C
11580-11610 ft			F						C
11610-11640 ft			F						C
11640-11670 ft			F		X				C
11670-11700 ft			C		X				C
11700-11730 ft			F		X				C
11730-11760 ft			F						C
11760-11790 ft			F						C
11790-11820 ft			F						C
11820-11850 ft			F			R			C
11850-11880 ft			C			F			C
11880-11910 ft			F		X				C
11910-11940 ft			R						C
11940-11970 ft			R						C
11970-12000 ft			X						C
12000-12030 ft			R						C
12030-12060 ft			R		R				C
12060-12090 ft			R		R				C

089 Sun No. 5 Blair

Fossil Distribution Chart

Plate 3.

Date: August 21, 2005
Analysts: E. Marks, S.K. Srivastaya
CAD: G. E. Koch
Client: Frank Getz
Project Number: 089
Operator: Sun Oil Company
Well: Sun No. 5 Blair
Section: Sec 4, Tnsp 7N, Rnge 32W, SBB&M
Area: Santa Maria
Location: La Laguna Field
County: Santa Barbara
Total Depth: 12500' (3811m)
Elevation: 1038.5' (3161m) KB

Environmental Legend

G2	General Moist
S2	Montane Moist
F2	Fluvial Moist
A0	Aquatic General
P1	Eupelagic
P2	Hemipelagic
B2	Benthic Peralic
B3	Benthic Shallow Marine
B4	Benthic Inner Neritic
B5	Benthic Middle Neritic
B6	Benthic Outer Neritic
B7	Benthic Upper Bathyal

Marks and Associates
5964 Fiji Street
Cypress, CA. 90630

Abundance Legend

X	Very Rare (+1)
R	Rare (2-4)
F	Few (5-8)
C	Common (9-32)
A	Abundant (33-120)
VA	Very Abundant (121-2000
FL	Flood (>2000)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	Actinocyclus ingens	Bisaccate conifer pollen	Coscinodiscus sp	Spongodiscus sp	Spongopyle osculosa	Stephanogonia hanzawae	Acrosphaera sp	Actinomma sp	Bolivina aff hughesi	Bolivina tumida	Buliminella ecuadorana	Cassidulina sp	Cibicides illingi	Denticula lauta	Dossetia lacera	Epistominella cf smithi	Fish bone fregments	Fungal spore	Globoquadrina humerosa	Hemicristellaria sp	Meliosira sulcata var biseriata	Onagraceae pollen	Picea sp 'silicified'	Prunopyle sp	Prunopyle titan	Rotalia becki	Siphocampe nodosaria	Sponge spicules tetra	Suggrunda californica	Theocorys redondoensis	Trochammina incerta
	P1Accsls	S2BaCoPo	P1Cnds01	P1Spds01	P1SpplOa	P1StgaHe	P1Acsa01	P1Acna01	B5BolaAH	B5BolaTa	B4BulaEa	B6Csda01	B4CibdIi	P1DntaLa	P1DstaLa	B6EplaCS	A0FishBo	G2FnglSr	P2GlboHa	B5Hcrs01	P1MlsaBa	F2Ongrce	S2Pcea01	P1Prpl01	P1PrplTn	B7RotaBi	P1ScpeNa	B3SpngTt	B6SggaCa	P1TcusRs	B2Trocla
12090-12120 ft	X	X	X	X	F	R																									
12120-12150 ft																															
12150-12180 ft			X		X		X	F	F	R	X	X	X	X	X	X	R	X	X	X	R	X	X	X	F	F	R	X	R	C	R
12180-12210 ft																															

TRITON 10 BLAIR FOSSIL DISTRIBUTION CHART

MARKS AND ASSOCIATES
5964 Fiji Street
Cypress, California 90630

Plate 4.

CLIENT: FRANK GETZ
PROJECT: TRITON 10 BLAIR
AREA: SANTA MARIA
LOCATION: BARHAM RANCH
SECTION: 3
TOWNSHIP: 7N
RANGE: 32 W SBB&M
COUNTY: SANTA BARBARA
ANALYST: E. Marks, I. Marks,J.Urban
DATE: 10/12/04

ENVIRONMENTAL LEGEND

- G0 General
- S0 Montane General
- A0 Aquatic General
- A2 Aquatic Moist
- A3 Aquatic Wet
- P1 Eupelagic
- B1 Benthonic Embayment
- B2 Benthic Paralic
- B3 Benthic Shallow Marine
- B4 Benthic Inner Neritic
- B5 Benthic Middle Neritic
- B6 Benthic Outer Neritic
- B7 Benthic Upper Bathyal
- B8 Benthic Middle Bathyal

ABUNDANCE LEGEND

- X Very Rare (+1)
- R Rare (2-4)
- F Few (5-8)
- C Common (9-32)
- A Abundant (33-120)
- VA Very Abundant (121-2000)
- FL Flood (>2000)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
	A0FshBA0	P1Spons0	P1Tyth01	B7BulaMo	B3ElphCt	P1GlbaCb	B2Hapd01	B4NonnGi	P1Rada01	B2Troc01	B6Vrga01	P1Hlsa01	P1Diat01	P1PrunTi	A2AlgaC?	P1CossSa	B4BuleCa	P1Coss01	B3Spro01	B6VrgaTi	B4Cibd01	B2Rotd01	P1CalsMs	B2Rota01	A3Spic07	B5Bola01	B8Gyra09	P1?Pen02	B7Pula01	B3BuleEa	B4Epnd01	S0WoodBT	G0SphrCl	B5Nonn09	B2RotaGs	B4NoneDs	B5Plma01	B6VrgaDs	B7Bula03	B2FormRW	B5Lgna04	B5Bola02	B7Uvga09	B2Frmn04	B4BuleSf	P1Glba01	B4NonnMm	B6Vrga09	B5BolaBa	B4BrzaGs	B6GbulCo	B8GyraSR	B2Ambc01	B4NonnMC	B5Nonn02	B4Bule02	S0Lign02	B4BrzaBs	B3BuleBr	B8Siga01	P1Spgs01	B3SpicTe	B1Echi02
	Fish Bone Fragments	Spongodiscus sp (R)	Tytthodiscus spp	Bulimina montereyana	Elphidium cf tumidum	Globigerina cf bulloides	Haplophragmoides sp	Nonion goudkoffi	Radiolaria sp	Trochammina spp	Virgulina sp	Heliosphaera spp (Rad)	Diatoms	Prunopyle titan	Algal cyst?	Coscinodiscus symbolophora	Buliminella curta	Coscinodiscus spp (D)	SPORBO	Virgulina ticensis	Cibicides Sp	Rotalid spp	Calocyclas margatensis (R)	Rotalia spp	Sponge Spicules Straight	Bolivina sp	Gyroidina spp indet.	Prunopyle fragment	Pullenia spp	Buliminella elegantissima	Eponides sp	Wood Fragments, bn,tn	Sphere, clear	Nonion spp indeterminate	Rotalia garveyensis	Nonionella davanaensis	Polymorphina sp	Virgulina delmonteensis	Bulimina spp indeterminate	Foraminifera	?Lagena sp	Bolivina sp fragments	Uvigerina spp indeterminate	?Foraminifera	Buliminella subfusiformis	Globigerina sp	Nonion montereyanum	Virgulina sp indeterminate	Bolivina barbarana	Brizalina girardensis	Globobulimina cf ovata	Gyroidina soldanii rotundimargo	Ammobaculites sp	Nonion medio-costatum	Nonion sp fragments	Buliminella sp Fragments	Lignite	Brizalina benedictensis	Buliminella brevior	Sigmoilina spp	Spongurus spp	Sponge Spicule tetra	Echinoid spine fragment
05090-05120 ft	X	R	X																																																																					
05120-05150 ft		X																																																																		
05150-05180 ft				R	X	X	X	R	X	X	X																																																										
05180-05210 ft		R										X																																																						
05210-05240 ft									R				F	X																																																				
05240-05270 ft									R				R		X	R																																																	
05270-05300 ft		R									X						X	X	X																																														
05300-05330 ft			X																	cfX																																															
05330-05360 ft	X																				X	X																																												
05360-05390 ft									R					X		R	X	R	R				R	X	X																																											
05390-05420 ft																X							X			X																																							
05420-05450 ft							X	X		X							X			X								X	X	X																																		
05450-05480 ft																	X		X									R			X	R	R																														
05480-05510 ft									R								X	R																X																													
05510-05540 ft																		X																	X	R																										
05540-05570 ft																														X																																	
05570-05600 ft							X									X				X										X						R	X	X																						
05600-05630 ft							R						X									X													X																											
05630-05660 ft		X							X							R		X																				X	X																						
05660-05690 ft																				X		X													X					X	R	X																			
05690-05720 ft		R	X				R	X	R				X																															X	X	X	R	X																	
05720-05750 ft				R				F								R	X			R										C						R		R										X	X	X	X											
05750-05780 ft							R									R	X				X	X								R				X				X																								
05780-05810 ft									X							R				X						X									X				R																					
05810-05840 ft							X															X		X					X																																	
05840-05870 ft													R				X											X		R						X		R										X												
05870-05900 ft								X	R									X																	X	X																								
05900-05930 ft								R	R											X										X						R		X										R												
05930-05960 ft									R				X					R		X										F					R																						X	X	X			
05960-05990 ft																																																												R			X			
05990-06020 ft		X	X										X						R																																									X			X		
06020-06050 ft		X							X							X																																											X				
06050-06080 ft																																																																	
06080-06110 ft							R																																																									X	

OTEC ONE BOYNE FOSSIL DISTRIBUTION CHART

MARKS AND ASSOCIATES
5963 FILI STREET
CYPRESS CA. 90630
CLIENT: FRANK GETZ
PROJECT: OTEC ONE BOYNE
AREA: SANTA MARIA
LOCATION: BARHAM RANCH
SECTION: 11
TOWNSHIP: T7N/R32W
RANGE: SBBW
COUNTY: SANTA BARBARA
ANALYST: EDWARD MARKS, IRENE MARKS, MICHAEL TRAPESONIAN
DATE: 8/29/03

ENVIRONMENTAL LEGEND

Platre 5.

G0	General	B2	Benthic Paralic
S0	Montane general	B3	Benthic Shallow Marine
A0	Aquatic General	B4	Benthic Inner Neritic
A3	Aquatic Wet	B5	Benthic Middle Neritic
		B6	Benthic Outer Neritic
		B7	Benthic Upper Bathyal
P1	Eupelagic	B8	Benthic Middle Bathyal

Abundance Legend X-Very Rare (1) R- Rare (2-4) F- Few (5-8) C- Common (9-32)
A - Abundant (33-120) VA- Very Abundant (121-2000) FL- Flood (>2000)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
	Bolivina sp	Buliminella subfusiformis	Haplophragmoides sp	Rotaliid sp flat	Wood Fragments, bn,tn	Diatoms	Fish Bone Fragments	Marginulina sp	Prunopyle titan	Radiolaria sp	Spongodiscus sp	Valvulineria sp	Bolivina sp fragments	Virgulina sp	Sigmoilina 6939	Molluscan Shell Fragments	Shark Tooth Fragments	Sponge Spicules Straight	Fish Jaw	Sphaeroidinellopsis subdehiscens	Ficus cf modesta	Bone Fragments	Bulimina montereyana	Gastropod shell fragments	Nonion spp indeterminate	Rotalia garveyensis	Rotalia spp	Virgulina ticensis	Nonionella cf extensa	Plant Roots pyritized	Sponge Spicule tetra	Wood Fragments, lignitized	Buliminella sp Fragments	Plant Fragments	Seed Pod	Coal	Virgulina grandis	Valvulineria araucana	Fish Teeth	Uvigerina modeloensis	Brizalina vaughani	Cibicides Sp	Mammalian Tooth
	B5Bola01	B4BuleSf	B2Hapd01	B2Rotld1	S0WoodBT	P1Diat01	A0FshBA0	B5Marg01	P1PrunTi	P1Rada01	P1Spons0	B6Vlvr01	B5Bola02	B6Vrga01	B8Siga30	SOMoll02	P1ShkT02	A3Spic07	A0FshJ01	P1SplsSs	B3FicsM	S0Bone02	B7BulaMo	B2Gast02	B5Nonn09	B2RotaGs	B2Rota01	B6VrgaTi	B4Nonece	G0PlntRp	B3SpicTe	S0WodFlg	B4Bule02	G0Plnt02	G0SdPd01	G0Coal01	B6VrgaGr	B6VlvrAr	A0FishTh	B7UvgaMo	B4BrzaVa	B4Cibd01	G0MamnTh
06750 -06780 ft	X	R	R	R	R																																						
06780-06810 ft			R	R	R	R	X	X	X	R	X																																
06810-06840 ft			X									R																															
06840-06870 ft				R																																							
06870-06900 ft													X	X																														
06900-06930 ft			R												X																												
06930-06960 ft			X										X			R																												
06960-06990 ft																R																												
06990-07020 ft																	X																												
07020-07050 ft			X															R																										
07050-07080 ft							R									R			X	X																								
07080-07110 ft																					X																							
07110-07140 ft													X																															
07140-07170 ft					C																																						
07170-07200 ft													X																															
07200-07230 ft																																											
07230-07260 ft																						X																					
07260-07290 ft			R																				X	X	X	X	X															
07290-07320 ft																										X																	
07320-07350 ft	X																											X															
07350-07380 ft			X																																								
07380-07410 ft			X																																								
07410-07440 ft			X																																								
07440-07470 ft			X							X						X		R																									
07470-07500 ft																																											
07500-07530 ft	X		C						X									C											X														
07530-07560 ft			X						X									C																									
07560-07590 ft	R																									X																	
07590-07620 ft										X								R												R	R												
07620-07650 ft										X								C												X													
07650-07680 ft					C	X												R												R		R											
07680-07710 ft			X							X								R															X	X	X								
07710-07740 ft		X	R							X																X					C				X								
07740-07770 ft			R		C		R			X								R													R												
07770-07800 ft										X																																		
07800-07830 ft							R			X								R																	X	X	X							
07830-07860 ft			R																					X		R			X							R							
07860-07890 ft																X										X										R	X							
07890-07920 ft																										X										X								
07920-07950 ft																										R																		
07950-07980 ft																X									X											X								
07980-08010 ft																R										X																		
08010-08040 ft																R																				X								
08040-08070 ft																																													
08070-08100 ft			X						X				X					X								X												X						
08100-08130 ft																										X			X														
08130-08160 ft	X																										X																	
08160-08190 ft					VA																					X	X												X	X				
08190-08220 ft					VA						X																		X									X		X	R	X	
08220-08250 ft					F																					X																	
08250-08280 ft	X				R							X																											X					
08280-08293 ft					VA						X																																	

APPENDIX F

ENVIRONMENTAL SUMMARY CHARTS

ENVIRONMENTAL SUMMARY CHARTS

PURPOSE

The purpose of environmental summary charts is to provide a graphic representation of the separate habitats that the fossils occupied. A comparison can be made between the habitats found and their abundances in the samples examined. Three other charts have been added, that of the species diversity noted in samples, that of the abundances of fossils and percentages of pelagics (Graph 17). Corroboration of environmental data based on many sources including Barker (21), Ingle (14) and Loeblich (18), as well as unpublished studies by the writer.

LAYOUT

Environmental Sumary Charts were prepared for three of the wells examined: OTEC No. 1 Boyne, TRITON No. 10 Blair and SUN No. 5 Blair [for the interval 3686 m (12090') to 3722 m (12210')]. The CABOT No. 1 Ferrero-Hopkins had so little data, we used what we found on the fossil distribution chart.

A legend is provided on each chart indicating the Operator, the well, the field,, the county and state, Santa Barbara County, California. Also indicated is the plate number, and the title of the chart. The Environmental Key lists the colors and the environments.

There are twenty one graphs illustrated in all the four wells. Not all graphs are indicated on each plate Only those whose habitats were noted were indicated. The rows display the sample depths, and the columns indicate the quantity of specimens. Most graphs are on an arithmetical scale. Because of the great abundances found in the well OTEC No. 1 Boyne, the Abundance Scale on Graph 2 in this well is expressed as a logarithmic scale. The graphs from Graph 3 to Graph 16 on the three plates represent the abundances of specimens found in the different habitats noted among the species found in the well. They are colored according to the environmental legend on their individual Fossil Distribution Charts, in Appendix E, above, as well as on the Environmental Charts, below. The last graph, "Percentages of Pelagics" in samples, represents the percentages of pelagic plankton, animals and plants that float in water at the surface or deeper, and not bottom dwellers.

GRAPHS

Graph 1, SPECIES DIVERSITY, is a histogram displaying the diversity of species in each sample. Species diversity is greater in the OTEC 1 Boyne early Mohnian , High Resistivity Monterey, below 2286 m (7500') and in the TRITON 10 Blair below 1698 m (5570'). In TRITON 10 Blair, the greatest amount of diversity appears above 1844 m – 1854 m (6050-6080'), and continues upward to 1698 m (5570'). Similar curves are found in the OTEC 1 Boyne. In these wells, the diversity and specimen abundance (Graph 2, below) graphs are directly proportional.

Graph 2, ABUNDANCES, is shown as a histogram in TRITON 10 Blair, and as a line chart in OTEC 1 Boyne displaying the abundances of all individuals found in each sample. In the TRITON 10 Blair, specimen abundances are greater in the early Mohnian, High Resistivity Monterey, below 1698 m (5570') than in the late Mohnian, Low Resistivity Monterey, showing only sporadic abundances.

Graph 3, G0, GENERAL, is a histogram, displaying the occurrences of forms that have universal ranges, and not restricted to few habitats. This graph is found in the TRITON 10 Blair, where only one specimen was attributed to General environments, a clear sphere that was found in the sample at 1671 m – 1680 m (5480-5510'), in the High Resistivity Monterey Formation. In the OTEC 1 Boyne, a number of plant roots and seeds were found that are placed in GO, General.

Graph 4, G2, GENERAL MOIST, is a histogram, displaying habitats of forms that prefer moist spots, such as the fungal spore found at 3704 m – 3713 m (12150-12180') in the SUN 5 Blair well.

Graph 5, S0, MONTANE, GENERAL, displays a histogram of forms that are found in montane habitats or deeper, such as wood fragments, In well TRITON 10 Blair, listed as Graph 4 in the sample at 1662 m - 1671m (5450-5480') and lignite, noted at 1790 m – 1799 m (5870-5900') and 1817 m – 1826 m (5960-5990'). All these forms were found in the early Mohnian, High Resistivity Monterey Formation in this well. In Graph 4 in the OTEC 1 Boyne well a few Montane General occurrences were noted from 2058 m (6750') to 2204 m (7230') but more were found from 2332 m (7650') to 2527 m (8290') in the late Miocene, early Mohnian, High Resistivity Monterey section.

Graph 6, S2, MONTANE MOIST, lists pine and hickory (*Picea sp)* that can be found in montane habitats where there is moisture. This habitat was noted in SUN 5 Blair, given as Graph 4, at 3686 m - 3695 m (12090'-12120'). The Low/High Resistivity Monterey is noted in this well at 3424 m (11230'), well above these occurrences.

GRAPHS, cont'd.

Graph 7, F2, FLUVIAL MOIST, listed as Graph 5 in the SUN 5 Blair, is a habitat where Onagraceae (Morning Glory, Primrose) pollen. This can be found in aquatic situations, but they were carried in the air or washed into an environment with deep water fossils. They were noted at 3704 m – 3713 m (12150 – 12180') in the SUN 5 Blair well.

Graph 8, A0, AQUATIC, GENERAL, lists fish bones. These could occur in fresh water as well as in marine conditions to the depths of the seas. Fish bones, fish teeth and a fish jaw were noted and plotted on Graph 5 in the OTEC 1 Boyne. They were scattered through the interval examined. In TRITON 10 Blair, listed on Graph 5, fish bones were present in the samples at 1552 m – 1558 m (5090-5110'), first sample and at 1625 m – 1634 m (5330-5360').

Graph 9, A2, AQUATIC, MOIST, represents in this well muddy but not necessarily wet conditions but also in deeper water. In the TRITON 10 Blair, an algal cyst? was noted in the sample at 1598 m – 1607 m (5240-5270') and displayed on Graph 6 on this well's chart..

Graph 10, A3, AQUATIC, WET, includes here straight sponge spicules that are usually found in deltas or embayments, as well as deeper marine conditions. In the OTEC 1 Boyne, sponge spicules were found from 2268 m (7440') to 2470 m (8100'), and are listed on Graph 6. In TRITON 10 Blair, one sample, at 5360-6390', contained one specimen of a sponge spicule, listed on Environmental Graph 7 in that well.

Graph 11, B1, BENTHIC, EMBAYMENT, represents forms that live in embayments or deeper. An echinoid spine fragment was noted in the last sample in TRITON 10 Blair at 1854 m – 1863 m (6080-6110'), and listed on Graph 8 there..

Graph 12, B2, BENTHIC, PARALIC, is a histogram listing the occurrences of Benthic, Paralic forms that live between high and low tide, also called intertidal. Listed as Graph 9 in TRITON 10 Blair, specimens of *Haplophragmoides sp.* are found from 1579 m (5180') to 1863 m (6110'), last sample. Specimens of *Trochammina sp.* were noted from 1570 m (5150') to 1771 m (5810'). Rotaliid species were seen from 1625 m (5330') to 1790 m (5870'). Specimens of *Rotalia sp.* appeared in the samples at 1634 m – 1643 m (5360-90') and at 1771 – 1780 m (5810-40'). The marker foram, *Rotalia garveyensis* was noted from 1680 m (5510') to 1799 m (5900'). A specimen of the paralic *Ammobaculites sp.* was noted in the sample at 1753 m –1762 m (5750-5780'). Some of these forms could have been washed down into deeper waters by ocean currents. A total of 12 samples contained Paralic forms in the High Resistivity Monterey section, below 1652 m (5420'), compared to 3 samples in the Low Resistivity Monterey section

above that depth. Benthic, Paralic forms in the OTEC 1 Boyne are listed in that well on Environmental Chart 7. Although sporadic in this well, there is a larger abundance from 2287 m (7500') and below, within the High Resistivity Monterey Fm.

Graph 13, B3, BENTHIC, SHALLOW MARINE, contains forms that inhabit the seas just below the low tide and in reefs or carried deeper by gravity. In the TRITON 10 Blair well, on Graph 10, Benthic Shallow Marine specimens were found in 12 samples below 1652 m (5420') in the High Resistivity Monterey unit; whereas they were found in just 3 samples in the Low Resistivity Monterey sediments, above. This includes a Tetrahedral sponge spicule, Marine, found at 5990-6020'. We have placed the enigmatic "SPORBO" (Spherical pellets or other round brown objects) probably phosphate pellets, in this environment. A specimen of the shallow marine *Elphidium cf tumidum* was found at 1570 m – 1579 m (5150-5180'), specimens of *Buliminella elegantissima* were noted from 1662 m (5450') to 1844 m (6050'), and a specimen of *Buliminella brevior* appeared in the sample at 1808 m – 1817 m (5930-5960'). The Benthic Shallow Marine is listed on Graph 8 in OTEC 1 Boyne with two entries, a specimen of *Ficus cf modesta* at 2158 m –2168 m (7080-7110') and specimens of tetractinellid sponges at 2314 m – 2323 m (7590-7620'). The SUN 5 Blair well contained Benthic Paralic forms, listed on Graph 8 in that well. The sample, 3704 m – 3713 m (12150-12180') revealed specimens of a tetractinellid sponge, a marine sponge.

Graph 14, B4, BENTHIC, INNER NERITIC, includes species that live below the low tide, but extend down into storm wave base or deeper. The lower limit is usually placed at 20± meters (50± feet), but they may live in deeper waters. In the TRITON 10 Blair, on Graph 11, Inner Neritic forms were noted in 14 samples below 1652 m (5420'), in the High Resistivity Monterey unit, but in only 4 samples above 1652 m (5420'). In OTEC 1 Boyne, one form was noted at 2058 m (6750'), first sample, and another at 2286m - 2296 m (7500-7530'). On Graph 8, the Inner Neritic is displayed in the Sun 5 Blair with two occurrences in the sample at 3704 m – 3713 m (12150-12180').

Graph 15, B5, BENTHIC, MIDDLE NERITIC, contains forms that live below wave base in quieter waters, in water depths from 20± meters (50± feet) to 100± meters (300± feet) or deeper. In the TRITON 10 Blair, on Graph 12, There were 8 samples containing Middle Neritic forms in the High Resistivity Monterey section below 1652 m (5420'), while 1 sample, at 1643 m – 1652 m (5390-5420') contained a specimen of the Middle Neritic *Bolivina sp*. In the OTEC 1 Boyne, Graph 10 displays ten Middle Neritic forms found at 2314 m (7590') or above, but only four occurrences below the same point. On the Environmental Graph 10 in SUN 5 Blair, the sample at 3704 m – 3713 m (12150-12180'). a number of

specimens of Middle Neritic *Bolivina spp* and *Hemcristellaria sp.* were noted.

Graph 16, B6, BENTHIC, OUTER NERITIC, indicates forms that live in deeper waters, from 100± meters (300± feet) to 200± meters (600± feet) and deeper. Sediments deposited in quieter waters may prove to be source rock or, in fractures, reservoir rock. In TRITON 10 Blair, on Graph 13, there were 9 samples containing Outer Neritic forms below 1652 m (5420')', as compared with 2 samples, above, in the Low Resistivity Monterey. In Graph 11, in OTEC 1 Boyne, we note 2 samples above 2232 m (7320') the highest early Mohnian found, and 4 samples including 2232 m (7320') below that point. The SUN 5 Blair contained 5 Outer Neritic specimens in the sample at 3704 m – 3713 m (12150-12180').

Graph 17, B7, BENTHIC, UPPER BATHYAL, includes forms that live below the edge of the continental shelf, at 200± meters (600± feet) to 500± meters (1500± feet), almost in total darkness or deeper. Upper Bathyal forms were noted in 4 samples in the TRITON 10 Blair, at Graph 14, with the greatest abundance at 1744 m – 1753 m (5720-5750'), within the High Resistivity Monterey section below 1652 m (5420'), and in 1 sample at 1570 m – 1579 m (5150-5180') in the Low Resistivity Monterey unit. A specimen of the Upper Bathyal *Bulimina montereyana* was reported at 2213 m – 2222 m (7260-7290'), in the late Mohnian in OTEC 1 Boyne. Also noted on Graph 12 in that well is the occurrence of the Upper Bathyal *Uvigerina modeloensis,* found at 2488 m – 2499 m (8160-8190'). In the SUN 5 Blair, on Graph 12, we noted 7 specimens found in the Upper Bathyal at 3704 m – 3713 m (12150-12180').in this well

Graph 18, B8, BENTHIC, MIDDLE BATHYAL, represents forms that live in darkness below 500± meters (1500± feet) and deeper. In the TRITON 10 Blair, on Graph 15, a total of 5 samples contained specimens whose habitats were Middle Bathyal in the High Resistivity Monterey, with none noted above in the Low Resistivity Monterey. No Middle Bathyal forms were found in the SUN 5 Blair samples examined.

Graph 19, P1, EUPELAGIC, contains forms that float at or near the surface of the open ocean to a depth of 20+m (50'). These forms, on dying, slowly float, pelagically, to the sea bottoms. In TRITON 10 Blair, on Graph 16, all forms noted were Radiolaria or Diatoms, siliceous, with the exception of one Globigerinid specimen, calcareous, each at 1570 m – 1579 m (5150-5180') and 1735 m – 1744 m (5690-5720') and the algal cysts, including the algal cyst marker, *Tytthodiscus sp,* noted in the first sample examined at 1552 m – 1561 m (5090-5120') and below. Both Monterey units contained Pelagic forms. The OTEC 1 Boyne, on Graph 14, displays individual occurrences of Pelagics in the samples from

GRAPHS, cont'd.

2268 m (7440') to 2387 m (7830') in the early Mohnian. There are infrequent appearances above that point, and three occurrences from 2460 m (8070') to 2528 m (8293'), last sample. In the SUN 5 Blair, on Graph 13, the Eupelagic, shallow floaters, are found in both samples, at 3686 m – 3695 m (12090-12120') and at 3704 m – 3713 m (12150-12180').

Graph 20, HEMIPELAGIC, contain forms that float in the open ocean between 20+m (50') and 100+m (200'). As in the Eupelagic habitat, these plants and animals on dying, slowly float pelagically to rest on the sea floor. The SUN 5 Blair contained a specimen, reported on the well's Fossil Distribution Chart and on its Environmental Graph 14. Based on live individuals, a specimen of the index fossil pelagic Foraminifer, *Globoquadrina humerosa* is considered Hemipelagic, and was found in the sample at 3704 m – 3713 m (12150-12180').

Graph 17, PERCENTAGE PELAGICS, displays percentages of Pelagic specimens compared to total specimens. This revealed the fact that in the well TRITON 10 Blair, in Graph 17, there was a higher percentage of Pelagics in the Low Resistivity Monterey unit, above 1652 m (5420') than in the High Resistivity Monterey unit below 1652 m (5420'). Four samples contained 80% or more total Pelagics above 1652 m (5420'), compared to all below 80% below 1652 m (5420'). Ten out of twelve samples (83%) contained Pelagics above 1652 m (5420'), while seventeen out of twenty three samples (74%) contained Pelagics below 1652 m (5420'). Three found above 1652 m (5420') were 100% Pelagics: 1561 m – 1570 m (5120-5150'), 1579 m – 1588 m (5180-5210') and 1588 m – 1598 m (5210-5240'). Further, the sample, 1598 m – 1607 m (5240-5270'), was 90% Pelagics. A graph, No. 15, Percentage Pelagics, was prepared for the well OTEC 1 Boyne. With lower fossil diversities and abundances, there were three samples containing pelagics above the late Miocene, early Mohnian top at 2232 m – 2240 m (7320-7350'). Below, with higher diversities and abundances in the early Mohnian interval, we found 13 pelagic occurrences. The SUN 5 Blair yielded pelagics only in the section below 3686 m (12090'). The sample at 3686 m – 3695 m (12090-12120') in this well was 100% pelagic, including Radiolaria and Diatoms, with conifer pollen, possibly airborne carried over water and deposited pelagically. The sample at 3704 m – 3713 m (12150-12180') contained about 55% pelagic, presenting a greater species diversity here. Twenty seven taxa were noted in sample 3704 m – 3713 m (12150-12180').

DISCUSSION

In well TRITON 10 Blair, both the Diversity and the Abundance graphs show a greater diversity and a greater abundance of fossils in the High Resistivity

Monterey section below 1652 m (5420'). A larger number of samples (78%) have Benthic specimens in the High Resistivity Monterey than in the Low Resistivity Monterey portion (22%) of the section examined. The percentage of Pelagics as compared with the whole assemblage is greater (83%) in the Low Resistivity Monterey Formation than in the High Resistivity Monterey Formation (74%). As many Benthic forms are not found in the Low Resistivity Monterey, but the Pelagics are higher, we may assume that the Low Resistivity Monterey was deposited in deeper waters than the High Resistivity Monterey. In deeper waters we find oozes that are high in Pelagic siliceous forms and/or globigerine forms with very little else in the samples. Ingle [14:29] illustrates a chart in the Monterey Formation comparing pelagic percentages and water depths. It is possible that low resistivity may be an example of lower porosity and high resistivity may be an example of higher porosity. Low resistivity may represent deeper and denser sediments with less porosity. High resistivity may represent shallower and less dense sediments with more porosity. In the Santa Maria Basin, which these wells represent, the Low Resistivity Monterey coincides with the late Miocene, late Mohnian material. Here, the High Resistivity Monterey coincides with the late Miocene, early Mohnian, and is the highly productive interval to look for.

The goal is to increase production, reduce operating costs and risks, and reduce environmental concerns in oil well drilling.

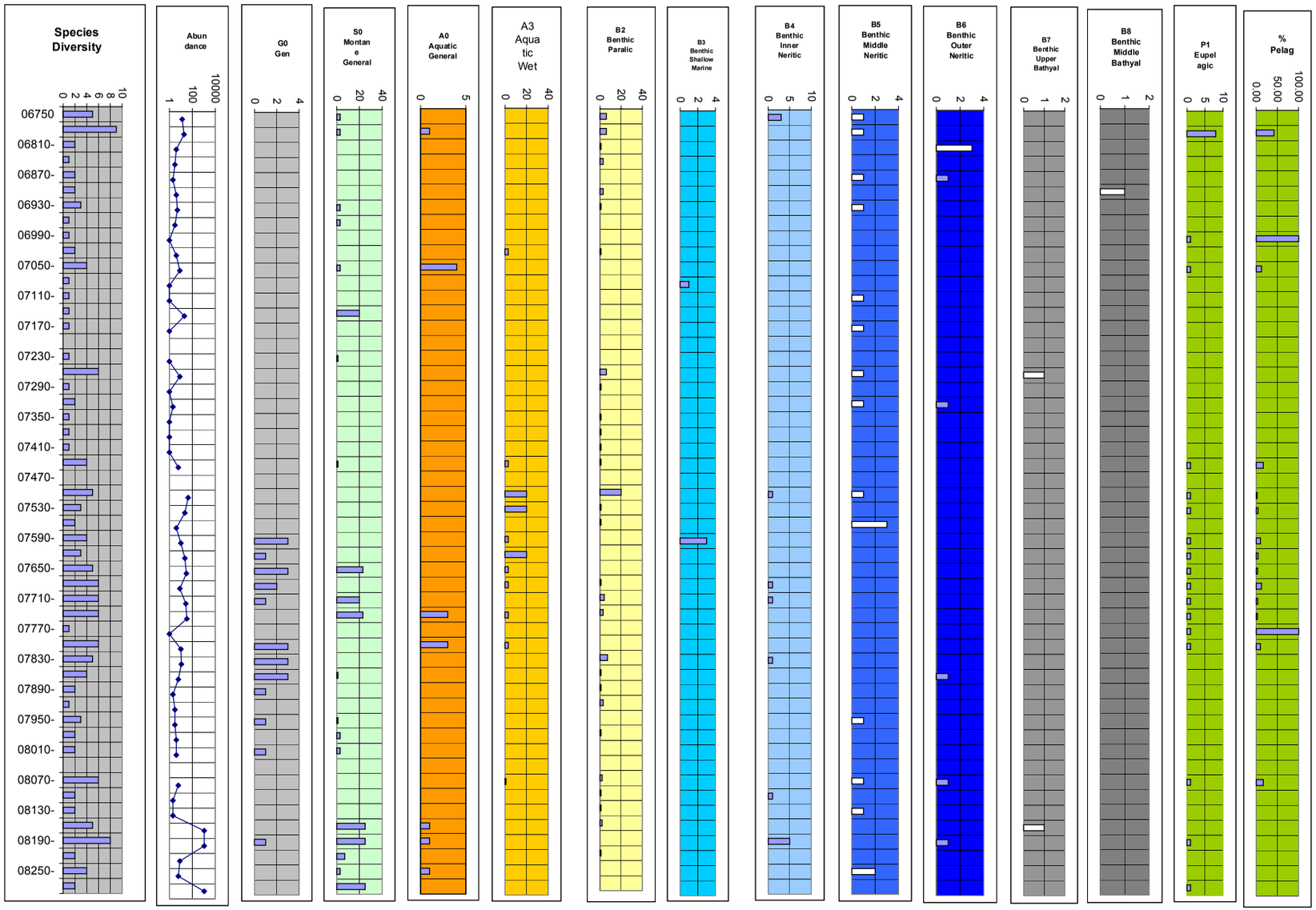
OTEC 1 Boyne
Barham nRanch Field
Santa Barbara Co. Ca.

Plate No. 6

Diversity, Abundance and Environmental Distribution Charts

Environmental Key

- G0 General
- S0 Mantane General
- A0 Aquatic General
- Aquatic Wet
- B2 Benthic Paralic
- B3 Benthic Shallow Marine
- B4 Benthic Inner Neritic
- B5 Benthic Nmidle Neritic
- B6 Benthic Outer Neritic
- B7 Benthic Upper Bathyal
- B8 Benthic Middle Bathyal
- P1 Euprlagic



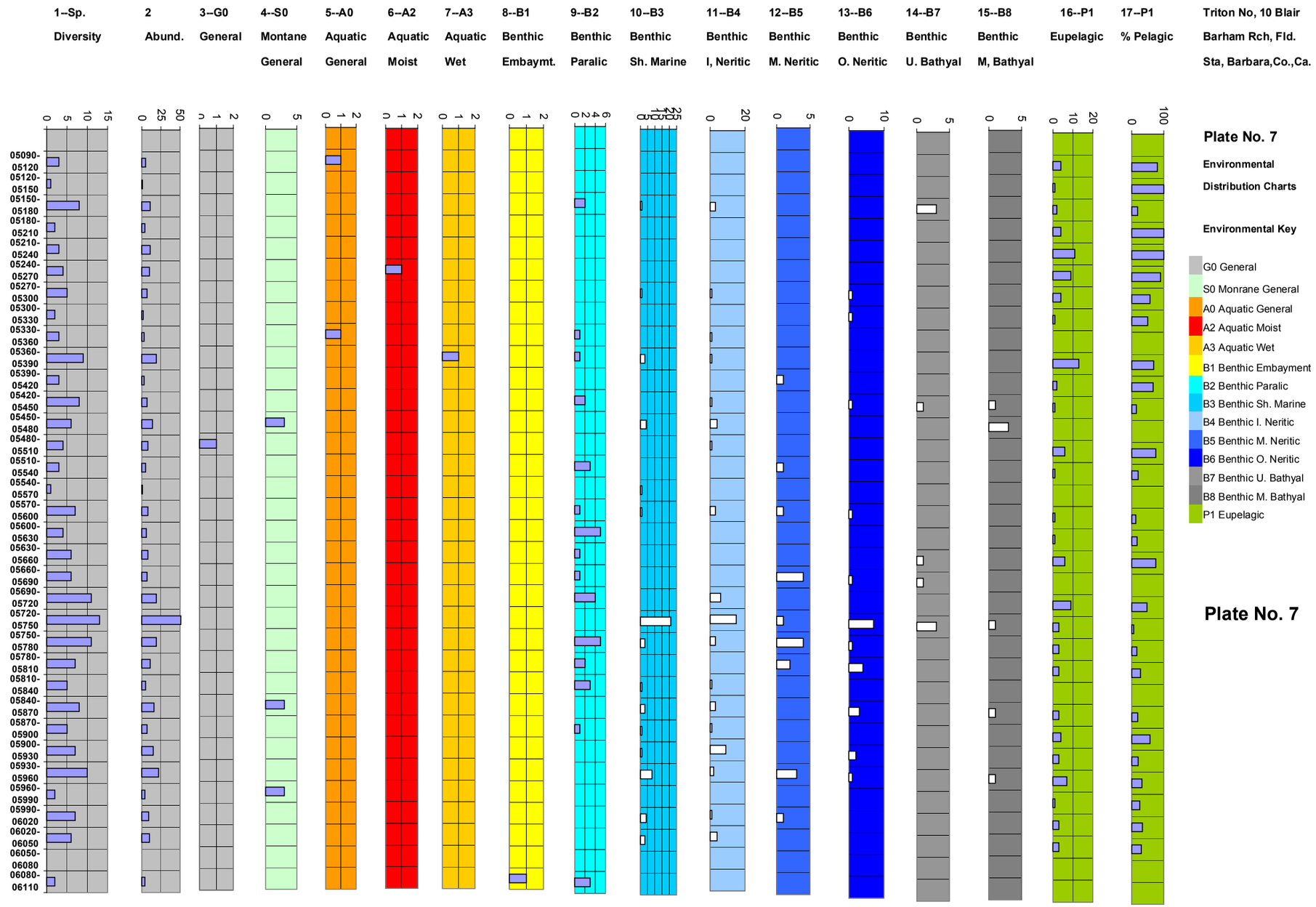

1--Sp. Diversity
2 Abund.
3--G0 General
4--S0 Montane General
5--A0 Aquatic General
6--A2 Aquatic Moist
7--A3 Aquatic Wet
8--B1 Benthic Embaymt.
9--B2 Benthic Paralic
10--B3 Benthic Sh. Marine
11--B4 Benthic I, Neritic
12--B5 Benthic M. Neritic
13--B6 Benthic O. Neritic
14--B7 Benthic U. Bathyal
15--B8 Benthic M, Bathyal
16--P1 Eupelagic
17--P1 % Pelagic
Triton No, 10 Blair
Barham Rch, Fld.
Sta, Barbara,Co.,Ca.
05090-05120
05120-05150
05150-05180
05180-05210
05210-05240
05240-05270
05270-05300
05300-05330
05330-05360
05360-05390
05390-05420
05420-05450
05450-05480
05480-05510
05510-05540
05540-05570
05570-05600
05600-05630
05630-05660
05660-05690
05690-05720
05720-05750
05750-05780
05780-05810
05810-05840
05840-05870
05870-05900
05900-05930
05930-05960
05960-05990
05990-06020
06020-06050
06050-06080
06080-06110
Plate No. 7
Environmental Distribution Charts
Environmental Key
G0 General
S0 Monrane General
A0 Aquatic General
A2 Aquatic Moist
A3 Aquatic Wet
B1 Benthic Embayment
B2 Benthic Paralic
B3 Benthic Sh. Marine
B4 Benthic I. Neritic
B5 Benthic M. Neritic
B6 Benthic O. Neritic
B7 Benthic U. Bathyal
B8 Benthic M. Bathyal
P1 Eupelagic
Plate No. 7

Plate 8. Sun No. 5 Blair, 12090' to 12210'. Environmental Distribution Charts

Environmental Key

- G2 General Moist
- S2 Montane Moist
- F2 Fluvial Moist
- A0 Aquatic General
- B2 Benthic Paralic
- B3 Benthic Shallow Marine
- B4 Inner Neritic
- B5 Benthic Middle Neritic
- B6 Benthic Outer Neritic
- B7 Benthic Upper Bathyal
- P1 Eupelagic
- P2 Hemipelagic
- Percent Pelagic